WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES 1990–2009

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AUTHORS

Richard A. Dolbeer, Science Advisor, Airport Wildlife Hazards Program, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, 6100 Columbus Ave., Sandusky, OH 44870

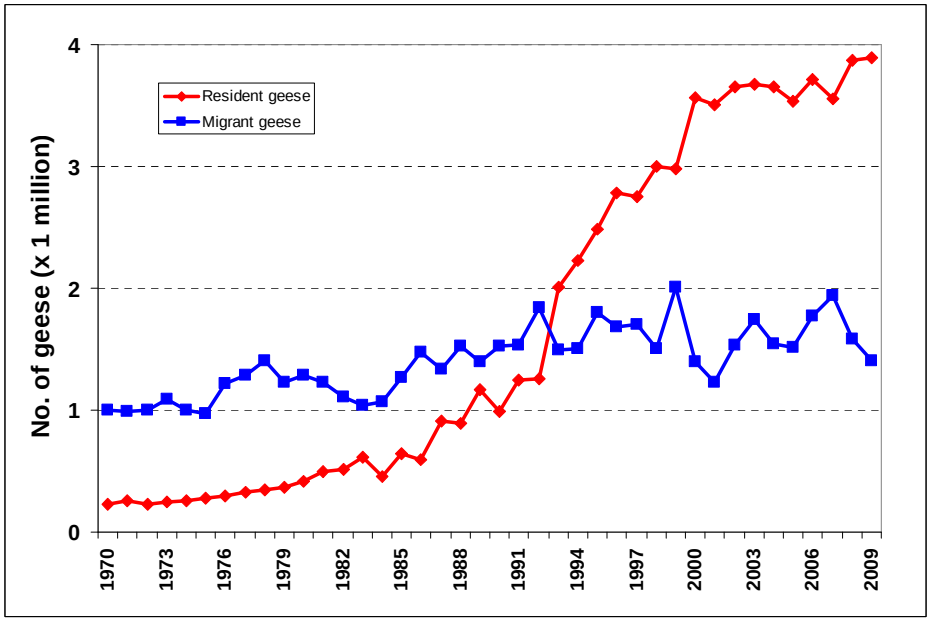
Sandra E. Wright, Wildlife Strike Database Manager, Airport Wildlife Hazards Program, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, 6100 Columbus Ave., Sandusky, OH 44870

John R. Weller, National Wildlife Biologist, Office of Airport Safety and Standards, Federal Aviation Administration, 800 Independence Ave., SW, Washington, DC 20591

Michael J. Begier, National Coordinator, Airports Wildlife Hazards Program, U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, 1400 Independence Ave., SW, Washington, DC 20250

COVER

The emergency forced landing of US Airways Flight 1549 in the Hudson River on 15 January 2009 after Canada geese were ingested in both engines on the Airbus 320 dramatically demonstrated to the public that bird strikes are a serious aviation safety issue. AP Photo.



The Canada goose population in North America (migrant and resident birds) increased from about 1.2 million in 1970 to 5.3 million in 2009 (Dolbeer and Seubert 2010).

Anyone with quality photographs of aircraft damage resulting from wildlife strikes or of wildlife at airports is encouraged to submit them to one of the authors for consideration in future wildlife strike publications.

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ACKNOWLEDGMENTS

The database files and support programs used to enter and organize strike data initially were established by ***E. LeBoeuf*** and ***J. Rapol,*** Federal Aviation Administration (FAA), Office of Airport Safety and Standards, Washington, DC, and were subsequently updated by ***A. M. Dickey*** and ***A. Newman,*** Embry-Riddle Aeronautical University, Prescott, AZ. ***E. C. Cleary***, who retired from the FAA in 2007, was instrumental in developing and co-authoring previous reports in this series. We acknowledge his long-standing contributions to the database. We greatly appreciate the assistance provided by these above-acknowledged professionals. ***S. Agrawal*** and ***R. King,*** FAA William J. Hughes Technical Center, Atlantic City, NJ, also provided critical support and advice. Finally, we acknowledge and thank all of the people who took the time and effort to report wildlife strikes — pilots, mechanics, control tower personnel, airport operations personnel, airline flight safety officers, USDA, Animal and Plant Health Inspection Service (APHIS), Wildlife Services biologists, and many others. Sponsorship and funds for the ongoing maintenance and analysis of the FAA National Wildlife Strike Database are provided by the FAA, Office of Airport Safety and Standards, Washington, DC; Airports Division, Airport Technology Branch, FAA William J. Hughes Technical Center, Atlantic City, NJ; and the Office of the Deputy Administrator, USDA APHIS Wildlife Services Program.

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EXECUTIVE SUMMARY

The emergency forced landing of US Airways Flight 1549 in the Hudson River on 15 January 2009 after Canada geese were ingested in both engines on the Airbus 320 dramatically demonstrated to the public that bird strikes are a serious aviation safety issue. However, the civil and military aviation communities have long recognized that the threat from aircraft collisions with wildlife (wildlife strikes) is real and increasing. Globally, wildlife strikes have killed more than 229 people and destroyed over 210 aircraft since 1988. Factors that contribute to this increasing threat are growing populations of large birds and increasing air traffic by quieter, turbofan-powered aircraft.

This report presents a summary analysis of data from the National Wildlife Strike Database (NWSD) for the 20-year period 1990 through 2009. To supplement the statistical summary of data, a sample of significant wildlife strikes to civil aircraft in the USA during 2009 is also presented to demonstrate the widespread and diverse nature of the problem.

The number of strikes annually reported has increased five-fold from 1,793 in 1990 to 9,474 in 2009 (99,411 for 1990–2009). During the five years between 2004 and 2008, there was an average of 20 reported wildlife strikes/ day. This increased to an average of 26 reported strikes per day in 2009; a 25-percent rise from 2008 and the largest single-year increase (1,872) for reported strikes. Birds were involved in 97.2 percent of the strikes, terrestrial mammals in 2.3 percent, bats in 0.4 percent, and reptiles in 0.1 percent. Although the number of reported strikes has steadily increased, the number of reported damaging strikes has actually declined from 765 in 2000 to 601 in 2009.

Fifty-two percent of bird strikes occurred between July and October; 31 percent of deer strikes occurred in October and November. Terrestrial mammals are more likely to be struck at night (63 percent), whereas birds are struck more often during the day (62 percent). Both birds (61 percent) and terrestrial mammals (63 percent) are more likely to be struck during the landing (i.e., descent, approach, or landing roll) phase of flight compared to take-off and climb (37 percent and 34 percent, respectively).

For commercial and general aviation (GA) aircraft, 72 and 76 percent of bird strikes, respectively, occurred at or below 500 feet above ground level (AGL). Above 500 feet AGL, the number of strikes declined by 33 percent for each 1,000-foot gain in height for commercial aircraft, and by 41 percent for GA aircraft.

From 1990 to 2009, 415 species of birds and 35 species of terrestrial mammals have been identified as struck by aircraft. Waterfowl, gulls, and raptors are the species groups of birds with the most damaging strikes; artiodactyls (mainly deer) and carnivores (mainly coyotes) are the terrestrial mammals with the most damaging strikes. Although the percentage of bird strikes causing damage has averaged 14 percent for the 20-year period, this number has declined from 20 percent in 1990 to 9 percent in 2009. For terrestrial mammals (20-year average of 61 percent), the decline has been from 86

percent in 1990 to 32 percent in 2009. Overall, 55 strikes have resulted in a destroyed aircraft; 33 (60 percent) of these occurred at GA airports.

This annual report is based on information from a portion of the available data fields contained in the NWSD. These reports provided summary information on the nature of wildlife strikes in a format that continues to be found useful by the aviation industry. The NWSD was made available by the FAA to the public on April 24, 2009, and interested parties now have the opportunity to query and examine the data independently at the newly updated FAA wildlife strike database website (http://wildlife.faa.gov). The new site has search fields that enable users to find data on specific airports, airlines, aircraft, and engine types, as well as damage incurred, date of strike, species struck, and state without having to download the entire database. The FAA also developed software to make strike reporting easier. Now, anyone who needs to report a wildlife strike can do so via the web or mobile devices like the Blackberry and iPhone. Although wildlife strike reporting is voluntary, and in some cases uneven, it has steadily increased and continues to provide adequate data to determine national trends and for the development of national policy. Analyses of the database can produce dissimilar comparisons that involve subject matter such as airports and airlines. Disparities that contribute to this variability include the presence/ absence of an airport-based wildlife hazard management program, integration of internal airline and airport strike reporting with the NWSD, variability in geography and topography of the airport, on-site and off-site habitats and wildlife attractants, aircraft type, number and time of day of aircraft movements, and the proximity of seasonal avian migration routes. Although the largest single-year increase for reported strikes occurred in 2009, there continues to be a need for increased reporting from GA airports, various certificated airports, and airlines and more detailed reporting of information (i.e., species identification, damage incurred, estimated costs) about wildlife strikes.

The successful mitigation efforts at airports that have reduced damaging strikes in recent years, which must be sustained, have done little to reduce strikes outside the airport such as occurred with US Airways Flight 1549 in 2009 (Dolbeer 2011, in press[1]). Consequently, additional measures are needed. First, the general public and aviation community must widen its view of wildlife management to consider habitats and land uses that attract hazardous wildlife within 5 miles of airports. Second, on-going research and mitigation efforts to further develop bird-detecting radar and bird migration forecasting and to study avian sensory perception to enhance aircraft detection and avoidance by birds should be maintained. Finally, Federal regulations and guidance on wildlife hazards at airports should continue to be reviewed and where necessary revised to incorporate new information about wildlife hazards and wildlife strike reporting trends. The FAA is taking a number of actions in these areas.

Effective and resourceful mitigation of wildlife hazards depends, in part, on quality strike data. There continues to be a need for increased and more detailed reporting of information about wildlife strikes. The FAA is focusing on improving the reporting rates of those airports and air carriers not fully participating in the program and in the transfer

[1] "In press" means the paper being cited has been officially accepted for publication but has not yet been published.

of data from miscellaneous FAA and industry databases under the existing voluntary system. Outreach efforts initiated to increase the quantity and quality of strike reports include the aforementioned updated FAA wildlife strike database website (http://wildlife.faa.gov), new strike reporting capabilities via mobile devices like the Blackberry and iPhone, and the creation of informational posters, placards, and quick reference thumb guides. The FAA and USDA have also increased outreach efforts through cooperative efforts with the Bird Strike Committee USA, Embry Riddle Aeronautical University, and various leading groups in the aviation community.

An Embraer 120 struck a white pelican at 2,600 feet above ground level after departure from an airport in Utah on 31 July 2009. The aircraft returned safely to the airport with the bird lodged in the radome. The aircraft was out of service for 48 hours; cost of repairs was $150,000. Photo courtesy G. Rokich.

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WILDLIFE STRIKES TO CIVIL AIRCRAFT IN THE UNITED STATES, 1990–2009

On 4 November 2009, a western grebe penetrated the windshield and injured the pilot of this Beechcraft 99 aircraft at about 6,800 feet above ground level on approach to an airport in Arizona. The pilot made an emergency landing. Photo courtesy K. Patterson.

INTRODUCTION

The emergency forced landing of US Airways Flight 1549 in the Hudson River on 15 January 2009 after Canada geese were ingested in both engines on the Airbus 320 (National Transportation Safety Board 2009, Marra et al. 2009) dramatically demonstrated to the public that bird strikes are a serious aviation safety issue. However, the civil and military aviation communities have long recognized that the threat to human health and safety from aircraft collisions with wildlife (wildlife strikes) is real and increasing (Dolbeer 2000, MacKinnon et al. 2001). Globally, wildlife strikes have killed more than 229 people and destroyed over 220 aircraft since 1988 (Richardson and West 2000; Thorpe 2003; 2005; Dolbeer, unpublished data). Three factors that contribute to this increasing threat:

1. Many populations of wildlife species commonly involved in strikes have increased markedly in the last few decades and adapted to living in urban environments, including airports. For example, from 1980 to 2007, the resident (non-migratory) Canada goose population in the USA and Canada increased at a mean rate of 7.3 percent per year (Sauer et al. 2008). Other species showing significant mean annual rates of increase included bald eagles (4.6 percent), wild turkeys (12.1 percent), turkey vultures (2.2 percent), American white pelicans (2.9 percent), double-crested cormorants (4.0 percent), and sandhill cranes (5.0 percent). Thirteen of the 14 bird species in North America with mean body masses greater than 8 pounds have shown significant population increases over the past three decades (Dolbeer and Eschenfelder 2003). The white-tailed deer population increased from a low of about 350,000 in 1900 to over 30 million in the past decade (Adams et al. 2009, McCabe and McCabe 1997, Hubbard et al. 2000).

2. Concurrent with population increases of many large bird species, air traffic has increased since 1980. Passenger enplanements in the USA increased from about 310 million in 1980 to 690 million in 2009 (2.8 percent per year), and commercial air traffic increased from about 18 million aircraft movements in 1980 to 26 million in 2009 (1.2 percent per year, Federal Aviation Administration 2010). USA commercial air traffic is predicted to continue growing at a rate of about 1.2 percent per year to 37 million movements by 2030.

3. Commercial air carriers have replaced their older three- or four-engine aircraft fleets with more efficient and quieter, two-engine aircraft. In 1965, about 90 percent of the 2,100 USA passenger aircraft had three or four engines. In 2005, the USA passenger fleet had grown to about 8,200 aircraft, and only about 10 percent had three or four engines (U.S. Department of Transportation 2009). With the steady advances in technology over the past several decades, today's two-engine aircraft are more powerful than yesterday's three- and four-engine aircraft, and they are more reliable. However, in the event of a multiple ingestion event (e.g., the US Airways Flight 1549 incident on 15 January 2009), aircraft with two engines may have vulnerabilities not shared by their three- or four-engine-equipped counterparts. In addition, previous research has indicated that birds are less able to detect and avoid modern jet aircraft with quieter turbofan engines (Chapter 3, International Civil Aviation Organization 1993) than older aircraft with noisier (Chapter 2) engines (Burger 1983, Kelly et al. 1999).

As a result of these factors, experts within the Federal Aviation Administration (FAA), U.S. Department of Agriculture (USDA), U.S. Navy, and U.S. Air Force expect the risk of wildlife-aircraft collisions to be a continuing challenge over the next decade.

The FAA has initiated several programs to address this important safety issue. Among the various programs is the collection and analysis of data from wildlife strikes. The FAA began collecting wildlife strike data in 1965. However, except for

cursory examinations of the strike reports to determine general trends, the data were never submitted to rigorous analysis until the 1990s. In 1995, the FAA, through an interagency agreement with the USDA, Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS), initiated a project to obtain more objective estimates of the magnitude and nature of the national wildlife strike problem for civil aviation. This project involves having specialists from the WS program: (1) edit all strike reports (FAA Form 5200-7, *Bird/Other Wildlife Strike Report*) received by the FAA since 1990 to ensure consistent, error-free data; (2) enter all edited strike reports in the NWSD; (3) supplement FAA-reported strikes with additional, non-duplicated strike reports from other sources; (4) provide the FAA with an updated computer file each month containing all edited strike reports; and (5) assist the FAA with the production of annual and special reports summarizing the results of analyses of the data from the NWSD. Such analyses are critical to determining the economic cost of wildlife strikes, the magnitude of safety issues, and most important, the nature of the problems (e.g., wildlife species involved, types of damage, height and phase of flight during which strikes occur, and seasonal patterns). The information obtained from these analyses provides the foundation for FAA policies and guidance and for refinements in the development, implementation, and justification of integrated research and management efforts to reduce wildlife strikes.

A medical Eurocopter 135 struck a black vulture on 8 November 2009 in North Carolina while en route, causing substantial damage to the tail. Aircraft made emergency landing in residential yard. Photo courtesy J. Gusler.

The first annual report on wildlife strikes to civil aircraft in the USA, covering 1994, was completed in November 1995 (Dolbeer et al. 1995). Since then we have published subsequent reports covering the years 1993–1995, 1992–1996, 1991–1997, 1990–1998, 1990–1999, 1990–2000, 1990–2001, 1990-2002, 1990-2003, 1990-2004, 1990-2005, 1990-2006, 1990-2007, and 1990–2008 (Cleary et al. 1996, 1997, 1998, 1999, 2000, 2002a, 2002b, 2003, 2004, 2005, 2006, 2007; Dolbeer and Wright 2008, Dolbeer et al. 2009). This is the 16th report in the series and covers the 20-year period of 1990 through 2009. The current and historic annual reports are accessible as PDF documents at http://wildlife.faa.gov.

This report presents a summary analysis of data from the FAA's National Wildlife Strike Database for the 20-year period 1990 through 2009. Unless noted otherwise, all totals are for the 20-year period, and percentages are of the total known.

Because of the large amount of data, most tables do not display data for individual years.

To supplement the statistical summary of data presented in tables and graphs, a sample of significant wildlife strikes to civil aircraft in the USA during 2009 is presented in Appendix A. These recent strike examples demonstrate the widespread and diverse nature of the problem. A more extensive list of significant strike events (1990-2009) and additional resources and reports are available at http://wildlife.faa.gov.

RESULTS

NUMBER OF REPORTED STRIKES

For the 20-year period (1990–2009), 99,411 strikes were reported to the FAA. Birds were involved in 97.2 percent of the reported strikes, terrestrial mammals in 2.3 percent, bats in 0.4 percent, and reptiles in 0.1 percent (Table 1).

The number of strikes annually reported has increased five-fold from 1,793 in 1990 to 9,474 in 2009 (Table 1, Figure 1). The 25-percent increase in reported strikes from 2008 to 2009 was the largest 1-year increase recorded. We suggest that the increase in reports of strikes, especially in 2009 following the Airbus 320 forced-landing in the Hudson River (NTSB 2010), primarily has been a result of an increased awareness of the wildlife strike issue and cooperation within the aviation industry to report strikes.

An MD-90 departing an Arizona airport on 2 November 2009 struck two western grebes at 9,300 feet above ground level. One grebe tore the fuselage above the eyebrow window, activating the depressurization alarm. The aircraft returned to airport safely. Photo courtesy L. Duncan.

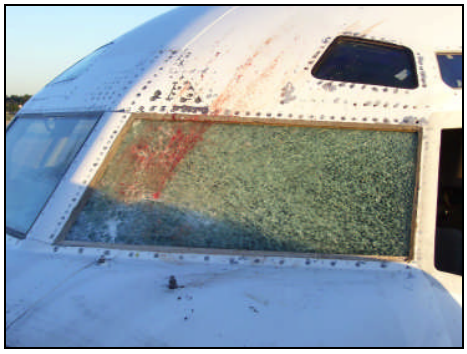
Although the number of reported strikes has steadily increased, it is important to note that the number of reported damaging strikes has actually declined in recent years. The number of reported strikes with damage to aircraft increased from 372 in 1990 to a peak of 765 in 2000. This number has subsequently declined by 21 percent to 601 in 2009 (Table 1, Figure 2). For commercial aircraft, the rate of damaging strikes (number per 100,000 aircraft movements) has also declined since 2000 (Table 2, Figures 3). The rate of damaging strikes with general aviation (GA) aircraft has remained

stable since 1997 (Table 3, Figure 3). These declines in damaging strikes for commercial aviation have occurred in spite of an increase in populations of hazardous wildlife species (Dolbeer 2000, Dolbeer and Eschenfelder 2003).

In May 2009**,** the FAA authorized a study through the FAA Airport Technology Research and Development Branch to review the NWSD and determine the current level of reporting and if it is sufficient to determine national trends. The study also reviewed whether strike reporting should be mandated and how the FAA can increase its data collection.

This study (Dolbeer 2009a,b) identified that the total number of strikes reported has increased from 20 percent during the period from 1990 to 1994 to 39 percent from 2004 to 2008 at airports certificated under 14 Code of Federal Regulations (CFR) Part 139. Although there is a higher level of reporting, the number of damaging strikes has not increased. This important fact is attributed to the successful implementation of professionally run wildlife hazard programs at many certificated airports. The current overall reporting rate of 39 percent is adequate to determine national trends in wildlife strikes, determine the hazard level of wildlife species that are being struck, and provide a scientific foundation for FAA policies and guidance on the mitigation of risk from wildlife strikes. As these are the main purposes of the NWSD, the FAA does not believe mandatory reporting is required at this time.

The study did identify reporting gaps among certificated airports, air carriers, and general aviation (GA) airports. Less than 6 percent of all strike reports come from GA airports identified in the National Plan of Integrated Airport Systems (NPIAS), and reporting rates average less than 1/20 of the rates at Part 139 airports. From 2004 to 2008, 84 (16 percent) Part 139 airports and 2,170 (85 percent) of the 2,560 NPIAS GA airports did not have a single strike reported. As a result, the FAA is conducting outreach with the aviation community and investigating the availability of alternative strike data sources to close these reporting gaps. The FAA also simplified strike reporting in July 2010 through the use of mobile devices and previously available online reporting. Now, anyone who needs to report a wildlife strike can do so via the web or their mobile devices. Additionally, continued emphasis on strike reporting requirements often incorporated into airport Wildlife Hazard Management Plans and annual wildlife hazard awareness training programs for airport personnel



A B-727 on final approach into a mid-southern USA airport at night on 29 September 2009 struck several migrating great egrets. Besides damage to the captain's windshield, bird remains were ingested in two engines. The plane landed safely. Photo courtesy FedEx.

should continue to benefit strike reporting.

METHODS OF REPORTING STRIKES

Most (68 percent) of the 99,411 strike reports submitted between 1990 and 2009 were filed using the paper (40 percent) or electronic (28 percent) version of FAA Form 5200-7, *Bird/Other Wildlife Strike Report*. Since the online version of this form became available in April 2001, use of the electronic reporting system has climbed dramatically. In 2009, 71 percent of the strike reports were submitted electronically compared to 20 percent in 2002 (Table 4).

SOURCE OF REPORTS

Airline personnel and pilots filed 28 percent and 24 percent of the strike reports, respectively, whereas 34 percent of known strikes were reported by airport ground personnel (Table 5). About 85 percent of the reported strikes involved commercial aircraft; the remainder involved business, private, and government aircraft (Table 6). Reports were received from all 50 states, from some USA territories, and from foreign countries when USA-registered aircraft were involved (Table 7). California, Texas, Florida, and New York had the most bird strike reports (8,347; 7,063; 6,230; and 5,237, respectively). Eleven other states each had more than 2,000 bird strikes reported. New York, Colorado, California, Texas, Illinois, New Jersey, and Michigan each had greater than 100 terrestrial mammal strikes. In all, strikes were reported at 1,822 airports (1,585 airports in the USA and 237 foreign airports where USA-based aircraft were involved).

TIMING OF OCCURRENCE AND PHASE OF FLIGHT OF STRIKES

Most bird strikes (52 percent) occurred between July and October (Figure 4); 62 percent occurred during the day (Table 8); 61 percent occurred during the landing (descent, approach, or landing roll) phase of flight; and 37 percent occurred during take-off run and climb (Table 9).

Most terrestrial mammal strikes occurred between July and November; with 31 percent of deer strikes concentrated in October-November (Figure 4). Most terrestrial mammal strikes (63 percent) occurred at night (Table 8), 63 percent occurred during the final approach or landing roll, and 34 percent occurred during the take-off run or initial climb (Table 9).

HEIGHT ABOVE GROUND LEVEL (AGL) OF STRIKES

Commercial aircraft – About 41 percent of the bird strikes with commercial aircraft occurred when the aircraft was at 0 feet AGL, 72 percent occurred at 500 feet or less AGL, and 92 percent occurred at or below 3,500 feet AGL (Table 10). Less than 1 percent of bird strikes occurred above 10,500 feet AGL. Above 500 feet AGL, the number of reported strikes declined consistently by 33 percent for each

1,000-foot gain in height (Figure 5). The record height for a reported bird strike involving a commercial aircraft in USA was 30,000 feet AGL.

General aviation (GA) aircraft – About 40 percent of the bird strikes with GA aircraft occurred when the aircraft was at 0 feet AGL, 76 percent occurred at 500 feet or less AGL, and 97 percent occurred at or below 3,500 feet AGL (Table 11). Less than 1 percent of bird strikes occurred above 10,500 feet AGL. Above 500 feet AGL, the number of reported strikes declined consistently by 41 percent for each 1,000-foot gain in height (Figure 5). The record height for a reported bird strike involving a GA aircraft in USA was 32,500 feet AGL.

Terrestrial mammal strikes predominately occurred at 0 feet AGL; however, 9 percent of the reported strikes occurred while the aircraft was in the air (e.g., when the aircraft struck deer or other wildlife with the landing gear) (Table 9).

AIRCRAFT COMPONENTS DAMAGED

The aircraft components most commonly reported as struck by birds were the nose/radome, windshield, engine, wing/rotor, and fuselage (Table 12). Aircraft engines were the component most frequently reported as being damaged by bird strikes (31 percent of all damaged components). There were 11,907 strike events in which a total of 12,493 engines were reported as struck (11,343 events with one engine struck, 547 with two engines struck, 12 with three engines struck, and 5 with four engines struck). In 3,638 damaging bird strike events involving engines, a total of 3,757 engines were damaged (3,522 events with one engine damaged, 114 with two engines damaged, 1 with three engines damaged, and 1 with four engines damaged).

On 14 November 2009, an Airbus 319 departing a central USA airport ingested snow geese into both engines at 4,000 feet above ground level. The #2 engine lost power. Pilot made an emergency landing at airport. Cost of repairs was $2.7 million. Photo courtesy B. Johnson.

Aircraft components most commonly reported as struck by terrestrial mammals were the landing gear, propeller, and wing/rotor. These same components ranked highest for the parts most often reported as damaged by mammals (Table 12).

REPORTED DAMAGE AND EFFECT-ON-FLIGHT

Of the 96,626 bird strikes reported, 74,855 provided some indication as to the nature and extent of any damage. Of these 74,855 reports, 64,670 (86 percent)

indicated the strike did not damage the aircraft; 5,407 (7 percent) indicated the aircraft suffered minor damage; 2,569 (3 percent) indicated the aircraft suffered substantial damage; 2,178 (3 percent) reported an uncertain level of damage; and 31 reports (less than 1 percent) indicated the aircraft was destroyed as a result of the strike (Table 13).

Of the 2,307 terrestrial mammal strikes reported, 1,499 reports provided some indication as to the nature and extent of any damage. Of these 1,499 reports, 582 (39 percent) indicated the strike did not damage the aircraft; 484 (32 percent) indicated the aircraft suffered minor damage; 348 (23 percent) indicated the aircraft suffered substantial damage; 61 (4 percent) reported an uncertain level of damage; and 24 (2 percent) indicated the aircraft was destroyed as a result of the strike (Table 13). Not surprisingly, a much higher percentage of terrestrial mammal strikes (61 percent) resulted in aircraft damage than did bird strikes (14 percent). Deer (964 strikes, Table 15) were involved in 42 percent of the 2,307 terrestrial mammal strikes.

Although the percentage of bird strikes causing damage averaged 14 percent for the 20-year period, this number has declined from 20 percent in 1990 to 9 percent in 2009. For terrestrial mammals (20-year average of 61 percent), the decline has been from 86 percent in 1990 to 32 percent in 2009 (Figure 6).

In 12 percent and 53 percent of the bird and terrestrial mammal strike reports, respectively, an adverse effect-on-flight was reported (Table 14). Three percent of bird strikes resulted in an aborted take-off compared to 17 percent of terrestrial mammal strikes.

Turkey vultures, because of their size and soaring behavior, are one of the most hazardous bird species to aviation. From 1990–2009, 363 strikes involving turkey vultures and civil aircraft were reported in USA.

WILDLIFE SPECIES INVOLVED IN STRIKES

Table 15 shows the number of reported strikes, strikes causing damage, strikes having a negative effect-on-flight, strikes involving more than one animal, the reported aircraft down time, and the reported costs by identified wildlife species for the 20-year period, 1990 through 2009.

Overall, 43,410 (45 percent) of the 96,626 bird strike reports provided information on the type of bird (e.g., gull or hawk). Furthermore, 28,469 (66 percent) of these 43,410 reports provided identification to species level (e.g., ring-billed gull or red-tailed hawk, Table 15). Thus, birds were identified to species level in 29 percent of the 96,626 reported bird strikes for the

period. Species identification has improved from less than 20 percent in the early 1990s to over 40 percent in 2008–2009 (Figure 7). In all, 415 species of birds have been identified as struck by aircraft, and 186 of these species were reported as causing damage during the 20-year period.

Gulls (18 percent), doves/pigeons (15 percent), raptors (13 percent), and waterfowl (8 percent) were the most frequently struck bird groups (Table 16). Gulls were involved in 2.3 times more strikes than waterfowl (7,894 and 3,391, respectively). Waterfowl, however, were involved in 1.2 times more damaging strikes (1,503 or 30 percent of all damaging strikes in which the bird type was identified) than were gulls (1,204 or 24 percent of all damaging strikes in which the bird type was identified). Gulls were responsible for the greatest number of bird strikes (1,862 or 21 percent) that involved multiple birds.

The most frequently struck terrestrial mammals were artiodactyls — primarily deer (44 percent) — and carnivores — primarily coyotes (32 percent) (Tables 15, 16). Artiodactyls were responsible for 93 percent of the mammal strikes that resulted in damage and 81 percent of the mammal strikes that involved multiple animals. In all, 35 identified species of terrestrial mammals and 8 identified species of bats were reported struck; 20 identified species of terrestrial mammals and 1 identified species of bat caused damage (Table 15).

From 1990–2009, at least 16 species of gulls were involved in 7,893 reported strikes with civil aircraft in the USA. It is widely recognized that open-faced, putrescible waste landfills and garbage containers attract gulls — the most frequently struck group of birds in the USA. However, these landfills and garbage containers also can attract other birds hazardous to aviation.

Table 17 ranks the 97 species of birds and 12 species of terrestrial mammals with 25 or more reported strikes (Table 15) by the percentage of strikes that resulted in damage to the aircraft. This ranking provides a means of objectively estimating the relative hazard level of species to aircraft operations.

Human Fatalities and Injuries Due to Wildlife Strikes

For the 20-year period, reports were received of 10 wildlife strikes that resulted in 24 human fatalities. Five of these strikes resulting in 7 fatalities involved unidentified species of birds. Red-tailed hawks (8), American white pelicans (5), Canada geese (2), white-tailed deer (1), and brown-pelicans (1) were responsible for the other 17 fatalities. Reports were received of 174 strikes that resulted in 217 human injuries. Waterfowl (ducks and geese; 42 strikes, 47 humans

injured), vultures (25 strikes, 27 injuries), and deer (20 strikes, 27 injuries) caused 87 (62 percent) of the 140 strikes resulting in injuries in which the species or species group was identified.

AIRCRAFT DESTROYED DUE TO WILDLIFE STRIKES

For the 20-year period, reports were received of 55 aircraft destroyed or damaged beyond repair due to wildlife strikes (Tables 13, 18). The majority (35 or 64 percent) were small (less than 2,250 kg maximum take-off mass) GA aircraft. Terrestrial mammals (primarily white-tailed deer) were responsible for 24 (44 percent) of the incidents. Canada geese (5 incidents) and vultures (3 incidents) were responsible for 8 (42 percent) of the 19 incidents involving birds in which the species or species group was identified.

Thirty-three (60 percent) of the 55 wildlife strikes resulting in a destroyed aircraft occurred at GA airports, 14 occurred away from an airport, 7 occurred at Part 139 airports, and 1 occurred at a foreign airport certificated for passenger service (Table 18). General aviation airports, often located in rural areas with inadequate fencing to exclude large mammals, face unique challenges in mitigating wildlife risks to aviation (DeVault et al. 2008; Dolbeer et al. 2008).

ECONOMIC LOSSES DUE TO WILDLIFE STRIKES

Although the number of reported strikes has steadily increased five-fold from 1,793 in 1990 to 9,474 in 2009 (99,411 for 1990–2009), the number of reported damaging strikes has actually declined from 765 in 2000 to 601 in 2009. For the 20-year period, reported losses from bird strikes totaled 424,936 hours of aircraft downtime and $374.9 million in monetary losses. Reported losses from terrestrial mammal strikes totaled 258,250 hours of aircraft downtime and $39.7 million in monetary losses. Bat strikes resulted in 102 hours of aircraft downtime and $3.2 million in losses. Reptile strikes resulted in 3 hours of aircraft downtime (Table 15).

Of the 16,518 reports that indicated the strike had an adverse effect on the aircraft and/or flight, 4,853 provided an estimate of the aircraft down time (Σ = 683,291 hours, avg. = 140.8 hours down time/incident, Table 19). Of the reports providing a damage cost estimate for the incident, 2,828 gave an estimate of the direct aircraft damage cost (Σ = $372.7 million, avg. = $131,798 damage/incident), and 1,340 gave an estimate of other monetary losses (Σ = $45.0 million, avg. = $33,603 lost/incident). Other monetary losses include such expenses as lost revenue, the cost of putting passengers in hotels, re-scheduling aircraft, and flight cancellations.

Analysis of 14 groups of strike reports from three Part 139 airports certificated for passenger service and three airlines for the years 1991 to 2004 indicated that 11 to 21 percent of all strikes were reported to the FAA (Cleary et al. 2005, Wright and Dolbeer 2005). An independent analysis of strike data for a certificated airport in

Hawaii in the 1990s indicated a similar reporting rate (Linnell et al. 1999). Analyses of strike data from 2004 to 2008 indicated strike reporting at Part 139 airports had improved to 39 percent (Dolbeer 2009a). Strike reporting for GA aircraft is estimated at less than 5 percent (Dolbeer et al. 2008, Dolbeer 2009a). In addition to the underreporting of strikes at GA airports, only 28 percent of the 16,518 reports from 1990 to 2009 indicating an adverse effect provided estimates of aircraft downtime, 17 percent provided estimates of direct costs, and 8 percent provided estimates of other (indirect) costs (Table 19). Furthermore, many reports providing cost estimates were filed before aircraft damage and downtime had been fully assessed. The FAA is working to improve the percentage of strike reports from GA aircraft.

Assuming (1) all 16,518 reported wildlife strikes that had an adverse effect on the aircraft and/or flight engendered similar amounts of downtime and/or monetary losses and (2) that these reports are all of the damaging strikes that occurred, then at a minimum, wildlife strikes cost the USA civil aviation industry 116,285 hours per year of aircraft downtime and $137 million in monetary losses ($109 million per year in direct costs and $28 million per year in associated costs, Table 19).

Further, if we assume that the 16,518 reported strikes indicating an adverse effect represent, on average, 20 percent of the total strikes that occurred with commercial and GA aircraft from 1990 to 2009, the annual cost of wildlife strikes to the USA civil aviation industry is estimated to be 581,424 hours of aircraft downtime and $683 million in monetary losses ($544 million per year in direct costs and $139 million per year in associated costs, Table 19).

Mitigating the risk of wildlife strikes at and in the vicinity of airports requires a comprehensive assessment of the hazardous wildlife species present and the supportive foods and habitats. Based on the assessment, a wildlife hazard management plan must be developed to eliminate these attractants and to disperse hazardous species. Photo courtesy USDA.

CONCLUSIONS

This analysis of 20 years of strike data reveals the magnitude and nature of wildlife strikes with civil aircraft in the USA and documents that progress is being made in reducing damaging strikes. Although wildlife strikes continue to pose a significant economic and safety risk for civil aviation in the USA, management actions to mitigate the risk have been implemented at many airports in the past decade (e.g., Wenning et al. 2004, DeFusco et al. 2005, Dolbeer 2006*a*, Human Wildlife Conflicts Journal 2009). These efforts are likely responsible for the general

decline in reported strikes with damage from 2000 to 2009 (Figures 2, 3) in spite of continued increases in populations of Canada geese and other large bird species. For example, USDA/APHIS/WS biologists provided assistance at 822 airports nationwide in 2009 to mitigate wildlife risks to aviation compared to only 42 airports in 1991 and 193 in 1998 (Begier and Dolbeer 2010). However, much work remains to be done to reduce wildlife strikes.

To address the problem, airport managers first need to assess the wildlife hazards on their airports with the help of qualified airport wildlife biologists (FAA Advisory Circular 150/5200-36). They then must take appropriate actions, under the guidance of professional biologists trained in wildlife damage management at airports, to minimize the risks posed by wildlife.

The manual *Wildlife Hazard Management at Airports* (Cleary and Dolbeer 2005) provides guidance to airport personnel and biologists on conducting wildlife hazard assessments and developing and implementing wildlife hazard management plans. PDF versions of the manual are available online in English, Spanish, and French at http://wildlife.faa.gov. The Airport Cooperative Research Program (ACRP) Report 32: *Guidebook for Addressing Aircraft/Wildlife Hazards at General Aviation Airports* (Cleary and Dickey 2010) provides similar guidance but specifically for the GA airport community.

Management efforts to reduce the risks of bird strikes have primarily focused on airports since various historical analyses of bird strike data for civil aviation have indicated the majority of strikes occur in this environment (during take-off and landing at ≤500 feet above ground level). Dolbeer (2011, in press) conducted a trend analysis of bird strike data involving commercial air carriers that indicated the percentage of all strikes that occurred at more than 500 feet increased significantly from about 25 percent in 1990 to 30 percent in 2009. The percentage of all *damaging* strikes that occurred at more than 500 feet increased at a greater rate, from about 37 percent in the early 1990s to 45 percent in 2005 to 2009. Dolbeer (2011, in press) also examined trends in strike rates (strikes/1 million commercial aircraft movements) for strikes occurring at less than or equal to and more than 500 feet. From 1990 to 2009, the damaging strike rate at more than 500 feet increased from about 2.5 to 4.0, whereas the damaging strike rate for strikes at 500 or less feet has remained stable since 2000. The successful mitigation efforts at airports that have reduced damaging strikes in recent years, which must be sustained, have done little to reduce strikes outside the airport such as occurred with US Airways Flight 1549 in 2009 (Dolbeer 2011, in press).

First, the general public and aviation community must widen its view of wildlife management to consider habitats and land uses within 5 miles of airports. Wetlands, dredge-spoil containment areas, municipal solid waste landfills, and wildlife refuges can attract hazardous wildlife. Such land uses, as discussed in FAA Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports,, are often incompatible with aviation safety and should either be prohibited

near airports or designed and operated in a manner that minimizes the attraction of hazardous wildlife. Second, on-going research and mitigation efforts to further develop and incorporate avian radar and bird migration forecasting and to study avian sensory perception to enhance aircraft detection and avoidance by birds should be maintained. Third, Federal regulations and guidance on wildlife hazards at airports should continue to be reviewed, and where necessary revised, to incorporate new information about wildlife hazards and wildlife strike reporting trends. Finally, there continues to be a need for increased and more detailed reporting of information about wildlife strikes, such as species identification and number of wildlife struck, time and altitude of strike, and damage estimation and/or final cost.

Cleary et al. (2005), Wright and Dolbeer (2005), and Dolbeer (2009a) indicated that strike reporting at Part 139 airports has increased from about 20 percent in the 1990s to 39 percent in 2004 to 2008. The percentage of bird strikes in which the bird was identified to species has improved from less than 20 percent in the early 1990s to over 40 percent in 2008 to 2009. Overall, only 17 percent of strike reports indicating an adverse effect on the aircraft or flight provided at least a partial estimate of economic losses resulting from the strike for the 20-year reporting period.

REPORTING A STRIKE AND IDENTIFYING SPECIES OF WILDLIFE STRUCK

Pilots, air traffic controllers, airport operations, aircraft maintenance personnel, and anyone else having knowledge of a strike should report the incident to the FAA using FAA Form 5200-7. Strikes can be reported electronically via the internet (http://wildlife.faa.gov) and mobile devices, or Form 5200-7 can be accessed and printed for mailing in reports.

It is important to include as much information as possible on FAA Form 5200-7. All reports are carefully screened to identify duplicate reports prior to being entered into the database. Reports of the same incident filed by different people are combined and often provide a more complete record of the strike event than would be possible if just one report were filed.

The identification of the exact species of wildlife struck (e.g., ring-billed gull, Canada goose, mallard, mourning dove, or red-tailed hawk as opposed to gull, goose, duck, dove, or hawk) is particularly important. This species information is critical for biologists developing and implementing wildlife risk management programs at airports because a problem that cannot be measured or defined cannot be solved. Bird strike remains that cannot be identified by airport personnel can often be identified by a local biologist trained in ornithology or by sending feather and other remains in a sealed plastic bag (with FAA Form 5200-7) to:

Material sent via Express Mail Service:	**Material sent via U.S. Postal Service:**
Feather Identification Lab Smithsonian Institution NMNH E600, MRC 116 10th & Constitution Ave NW Washington, DC 20560-0116 (label package "safety investigation material") Phone: 202-633-0787 or 202-633-0791	Feather Identification Lab Smithsonian Institution NMNH E600, MRC 116 PO Box 37012 Washington, DC 20013-7012 (not recommended for priority cases)

The number of bird strike cases processed by the Smithsonian Feather Identification Lab for the FAA (civil aviation) in FY 2009 was 983 with 1,064 separate identifications of species (C. Dove, unpublished data). In addition, the Lab processed 3,538 cases with 4,355 identifications for the U.S. Air Force and 400 cases with 415 identifications for the Navy (not discussed in this report). Approximately 18 percent of the bird strike cases submitted for identification included multiple samples or impact points. DNA analysis was used in 68 percent of all identifications to identify, supplement, or verify traditional identification methods.

Whenever possible, reporters should send whole feathers as diagnostic characteristics are often found in the downy barbules at the feather base. Wings, as well as breast and tail feathers, should be sent whenever possible. Beaks, feet, bones, and talons are also useful diagnostic materials. Even blood smears can provide material for DNA analysis (Dove et al. 2008). Do not send entire bird carcasses through the mail. However, photographs of the carcasses can be very useful supplemental documentation.

Guidelines for Collecting Bird Strike Material

- Always include any feather material available.
- Include copy of report (AFSAS, WESS, or FAA 5200-7).
- Always secure all remains in re-sealable plastic bag.

Feathers:

Whole Bird – Pluck a variety of feathers (breast, back, wing, tail)
Partial Bird – Collect a variety of feathers with color or pattern
Feathers only – Send all material available. Do not cut feathers from the bird (downy part at the base of the feathers is needed). Do not use any sticky substance (no tape or glue).

Tissue/blood ("Snarge"):

Dry material – Scrape or wipe off into a clean re-closeable bag **or** wipe area with pre-packaged alcohol wipe **or** spray with alcohol to loosen material then wipe with clean cloth/gauze. (Do not use water, bleach, or other cleansers; they destroy DNA.)

Fresh material – Wipe area with alcohol wipe and/or clean cloth/gauze **or** apply fresh tissue/blood to an FTA® DNA collecting card.

FTA® Micro Card and Sterile Applicators

If you send a lot of fresh blood/ tissue samples for DNA identification, you may want to consider getting Whatman FTA® DNA cards. The material is sampled with a sterile applicator and placed onto the surface of the card that "fixes" the DNA in the sample. For more information on ordering these items contact the Feather Lab.

Note: If you only occasionally send blood/ tissue samples, a paper towel with alcohol or alcohol wipe is still a good option for this type of material.

Additional information on sending bird remains to the Smithsonian is available at http://wildlife.faa.gov.

FAA Activities for Mitigating Wildlife Strikes

In 2010, the FAA continued a multifaceted approach for mitigating wildlife strikes. This included continuing a robust research program, making improvements to the NWSD and outreach, incorporating new technology to increase and simplify strike reporting, and providing Airport Improvement Program (AIP) funding to airports to conduct Wildlife Hazard Assessments (WHAs) and develop Wildlife Hazard Management Plans (WHMPs).

Strike Reporting

Following the US Airways Flight 1549 accident, there was considerable public attention on the estimated 20-percent strike reporting rate in the USA. This rate had been based on studies in the mid 1990s and early 2000s. The FAA believed that the actual current level of strike reporting was higher because of the proliferation of wildlife hazard mitigation efforts at airports as well as outreach efforts by the FAA and the USDA.

As described above, in May 2009**,** the FAA authorized a study through the FAA Airport Technology Research and Development Branch to review the National Wildlife Strike Database and determine the current level of reporting and if it is sufficient to determine national trends and develop national policy. The report also reviewed whether strike reporting should be mandated and how the FAA could increase its data collection. The report (Dolbeer 2009a,b) concluded that the reporting rate has increased from 20 percent for the period 1990 to1994 to 39 percent for 2004 to 2008 at Part 139 airports.

As there is still room for improvement, the FAA retooled the existing wildlife strike database website (http://wildlife-mitigation.tc.faa.gov/wildlife/) to make it more user-friendly and to allow more advanced data mining. The new site (http://wildlife.faa.gov) has search fields that enable users to find data on specific airports, airlines, aircraft and engine types, as well as damage incurred, date of strike, species struck, and state without having to download the entire database.

The FAA also developed software to make strike reporting easier. Now, anyone who needs to report a wildlife strike can do so via the web or their mobile devices. Also, the FAA made strike reporting easier by creating a generic web site. When airline and airport employees report a wildlife strike, the information is automatically sent to the FAA's wildlife strike database.

Wildlife Hazard Mitigation Research

For the last 15 years, the FAA and the USDA have conducted a research program to make airports safer by reducing the risks of aircraft-wildlife collisions. The research efforts designed to improve wildlife management techniques and practices on and near airports include:

- Methods for making airport habitats less attractive to species that are the most dangerous in terms of aircraft collisions. This is accomplished by studying which species use the airport property, how they behave in that environment, and why they are attracted
- Techniques for controlling species by restricting access to attractive features like storm water ponds
- Technologies for harassing and deterring hazardous species
- Evaluation of avian radar systems for detecting and tracking birds on or near airports
- Aircraft-mounted alternating, pulse lights to enhance aircraft detection and deter wildlife strikes

Cooperative research between the USDA/APHIS/Wildlife Services National Wildlife Research Center and North Carolina State University investigated resident Canada goose behavior, movement patterns, and habitat preference throughout the greater Greensboro, NC, area. Photo courtesy J. Weller.

Bird Radar

In 2001, the FAA began working with the U.S. Air Force to develop a radar system for detecting and tracking birds on or near airports. In 2006, the FAA refocused the radar research to evaluate the capability of commercially available, low-cost, portable radars to reliably detect and track birds on or near airports.

Bird radars were evaluated at Seattle-Tacoma International Airport and the Whidbey Island Naval Air Station in 2007, followed by deployments at Chicago's O'Hare International Airport and New York's John F. Kennedy International Airport in 2009 and 2010, respectively. As a result of the radar evaluation, the FAA published a performance specification, Advisory Circular 150/5220-25, Airport Avian Radar Systems, that airports can use for the competitive procurement of bird radar systems. The guidelines provide the operational considerations of acquiring and using the technology to enhance wildlife hazard mitigation practices on civil airports. Under some circumstances, procurement of bird radar systems may be eligible for funding under the FAA's Airport Improvement Program (AIP).

Wildlife Hazard Assessments and Wildlife Hazard Management Plans

The FAA is encouraging all certificated airports to conduct wildlife hazard assessments until finalization of a proposal to require all Part 139 certificated airports to complete a WHA. In response to National Transportation Safety Board (NTSB) Recommendation A-10-75, the FAA has proposed amending 14 CFR §

139.337 to require all Part 139 certificated airports to conduct a WHA, require periodic completion of a WHA, provide an option for continuous wildlife monitoring as an alternative to periodic WHAs, and clarify the requirements for personnel conducting a WHA. These WHAs will allow an airport to:

- Identify trends in wildlife use of the airport (habitat preferences, seasonal composition and abundance of wildlife species, geography of strikes, seasonality of strikes, time and phase of flight of strikes, etc.)
- Prevent future strikes through operational changes, habitat (attractant) modifications, customized harassment, and/ or species removal
- Evaluate the overall risk level of wildlife strikes and the efficacy of the airport's wildlife hazard mitigation program (e.g., determine redundancy of species specific hazards, monitor reduction of onsite damaging strikes, monitor wildlife program communication and response efficiency, and improve overall program through annual review)

A WHA provides fundamental wildlife and habitat information for an effective, airport-specific WHMP. The WHMP outlines a plan of action to minimize the risk to aviation safety, airport structures or equipment, or human health posed by populations of hazardous wildlife on and around an airport. The FAA supports completion of wildlife hazard assessments and wildlife hazard management plans by providing financial assistance from the AIP.

Mitigating Strikes at GA Airports

The FAA is also encouraging federally-obligated GA airports to conduct Wildlife Hazard Assessments. . For example, one of the ways the FAA has done that is by sponsoring a research study under the Airport Cooperative Research Program (ACRP). The final report, *Guidebook for Addressing Aircraft/Wildlife Hazards at General Aviation Airports* has been published. It provides practical guidance on how to address wildlife strikes at airports with a specific emphasis on the general aviation community.

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TABLES

Table 1. Number of reported wildlife strikes to civil aircraft by wildlife group, USA, 1990–2009 (see Figures 1 and 2).

Year	Birds	Bats	Terrestrial mammals[1]	Reptiles[1]	Total strikes	Strikes with damage
1990	1,737	4	52	0	1,793	372
1991	2,252	3	54	0	2,309	398
1992	2,351	2	73	1	2,427	366
1993	2,391	6	67	0	2,464	399
1994	2,458	2	82	1	2,543	462
1995	2,640	5	84	8	2,737	499
1996	2,838	1	91	3	2,933	504
1997	3,350	1	95	14	3,460	581
1998	3,654	3	111	7	3,775	590
1999	5,001	7	96	1	5,105	704
2000	5,863	16	124	3	6,006	765
2001	5,636	8	139	8	5,791	644
2002	6,045	19	119	15	6,198	671
2003	5,850	20	127	5	6,002	631
2004	6,401	27	127	6	6,561	623
2005	7,076	27	132	7	7,242	607
2006	7,036	49	143	10	7,238	598
2007	7,516	53	175	7	7,751	568
2008	7,368	46	183	5	7,602	527
2009	9,163	68	233	10	9,474	601
Total	**96,626**	**367**	**2,307**	**111**	**99,411**	**11,110**

[1] For terrestrial mammals and reptiles, species with body masses <1 kilogram (2.2 lbs) are excluded from database (Dolbeer et al. 2005).

Table 2. Number and rate of reported wildlife strikes and strikes with damage for commercial air carrier aircraft, USA, 1990–2009 (see Figure 3).

	No. of reported strikes			Strikes/100,000 movements	
Year	All strikes	Strikes with damage	Aircraft movements (x 1 million)[1]	All strikes	Strikes with damage
1990	1,336	213	23.27	5.74	0.92
1991	1,775	250	24.79	7.16	1.01
1992	1,806	210	25.18	7.17	0.83
1993	1,779	229	25.57	6.96	0.90
1994	1,903	281	26.59	7.16	1.06
1995	2,017	321	27.05	7.46	1.19
1996	2,086	312	27.58	7.56	1.13
1997	2,456	363	27.77	8.84	1.31
1998	2,515	363	28.01	8.98	1.30
1999	3,849	474	28.76	13.38	1.65
2000	4,472	510	29.54	15.14	1.73
2001	4,155	442	29.16	14.25	1.52
2002	4,405	463	27.62	15.95	1.68
2003	4,280	416	27.91	15.34	1.49
2004	4,686	402	28.89	16.22	1.39
2005	5,164	417	29.25	17.65	1.43
2006	4,908	404	28.31	17.34	1.43
2007	5,002	353	28.47	17.57	1.24
2008	4,574	332	27.95	16.36	1.19
2009	6,089	386	25.48	23.90	1.51
Total	69,257	7,141	547.15	12.66	1.31

[1] Departures and arrivals by air carrier, commuter, and air taxi service (FAA 2010).

Table 3. Number and rate of reported wildlife strikes and strikes with damage for general aviation aircraft, USA, 1990–2009 (see Figure 3).

	No. of reported strikes			Strikes/100,000 movements	
Year	All strikes	Strikes with damage	Aircraft movements (x 1 million)[1]	All strikes	Strikes with damage
1990	457	159	77.83	0.59	0.20
1991	534	148	83.84	0.64	0.18
1992	621	156	82.63	0.75	0.19
1993	685	170	80.70	0.85	0.21
1994	640	181	79.50	0.81	0.23
1995	720	178	77.52	0.93	0.23
1996	847	192	79.30	1.07	0.24
1997	1,004	218	80.27	1.25	0.27
1998	1,260	227	84.60	1.49	0.27
1999	1,256	230	85.70	1.47	0.27
2000	1,534	255	87.47	1.75	0.29
2001	1,636	202	86.31	1.90	0.23
2002	1,793	208	86.17	2.08	0.24
2003	1,722	215	83.84	2.05	0.26
2004	1,875	221	83.08	2.26	0.27
2005	2,078	190	81.56	2.55	0.23
2006	2,330	194	80.57	2.89	0.24
2007	2,749	215	80.75	3.40	0.27
2008	3,028	195	78.23	3.87	0.25
2009	3,385	215	74.56	4.54	0.29
Total	30,154	3,969	1,634.42	1.84	0.24

[1] Itinerant and local departures and arrivals by general aviation aircraft (FAA 2010).

Table 4. Source of information for reported wildlife strikes to civil aircraft, USA, 1990–2009.

Source	20-year total	% of total known
FAA Form 5200-7[1] (Paper)	39,815	40
FAA Form 5200-7E[2] (Electronic)	27,727	28
Airline report	13,522	14
Multiple[3]	8,706	9
Airport report	4,608	5
Other[4]	1,405	1
Preliminary Aircraft Incident Report	889	1
Engine manufacturer	858	1
Aircraft Incident Report	826	1
Daily Report (FAA)	711	1
Aviation Safety Reporting System	196	0
National Transportation Safety Board	80	0
Aircraft Incident Preliminary Notice	68	0
Total	**99,411**	**100**

[1] Bird/Other Wildlife Strike Report.

[2] Electronic filing of reports (http://wildlife.faa.gov) began in April 2001. In 2001, 0.4 percent of reports were filed electronically compared to 20, 28, 32, 37, 46, 62, 67, and 71 percent in 2002 through 2009, respectively. The paper version of FAA Form 5200-7 (mailed to FAA headquarters) declined from 57 percent of all reports in 2001 to 9 percent in 2009.

[3] More than one type of report was filed for the same strike.

[4] Various sources, such as news media and Commercial Incident Reports.

Table 5. Person filing report of wildlife strike to civil aircraft, USA, 1990–2009.

Person filing report	20-year total	% of total known
Airline Operations	22,801	28
Pilot	19,598	24
Carcass Found[1]	16,696	21
Airport Operations	10,317	13
Tower	9,839	12
Other	2,085	3
Total known	**81,336**	**100**
Unknown	**18,075**	
Total	**99,411**	

[1] Airport personnel found wildlife remains within 200 feet of a runway centerline that appeared to have been struck by aircraft and no strike was reported by pilot, tower, or airline.

Table 6. Number of reported wildlife strikes to civil aircraft by type of operator, USA, 1990–2009.

Type of operator	20-year total	% of total known
Commercial	69,257	85
Business	9,141	11
Private	2,156	3
Government/ Police[1]	501	1
Total known	**81,055**	**100**
Unknown	**18,356**	
Total	**99,411**	

[1] U.S. Coast Guard aircraft were involved in 152 of these strikes.

Table 7. Number of reported bird, bat, terrestrial mammal, and reptile strikes to civil aircraft by USA state, including the District of Columbia (DC), Puerto Rico (PR), USA-possessed Pacific Islands (PI), and the U.S. Virgin Islands (VI), 1990–2009.

State	Reported strikes (20-year total)					State	Reported strikes (20-year total)				
	Birds	Bats	T. mammals	Reptiles	Total		Birds	Bats	T. mammals	Reptiles	Total
AK	686	1	35	0	722	NC	1,600	2	35	0	1,637
AL	783	2	11	0	796	ND	324	0	16	0	340
AR	373	1	20	1	395	NE	1,069	10	17	0	1,096
AZ	1,569	36	74	0	1,679	NH	500	7	7	0	514
CA	8,347	6	137	0	8,490	NJ	2,694	4	114	11	2,823
CO	3,347	14	156	0	3,517	NM	254	2	32	0	288
CT	982	1	22	0	1,005	NV	484	0	11	0	495
DC	2,053	4	47	2	2,105	NY	5,237	9	166	26	5,438
DE	81	0	1	0	82	OH	3,202	11	100	0	3,313
FL	6,230	13	83	49	6,375	OK	913	1	37	5	956
GA	1,475	2	35	0	1,512	OR	1,624	2	12	0	1,638
HI	2,203	0	8	0	2,211	PA	3,066	6	97	0	3,169
IA	732	2	25	0	759	PI	162	0	0	0	162
ID	250	0	10	0	260	PR	173	2	0	6	181
IL	4,380	6	116	1	4,503	RI	392	1	14	0	407
IN	1,302	2	30	0	1,334	SC	449	0	26	0	475
KS	330	1	12	0	343	SD	236	0	14	1	251
KY	2,478	5	21	0	2,504	TN	2,951	2	22	0	2,975
LA	1,708	11	25	2	1,746	TX	7,063	110	135	1	7,309
MA	1,277	1	25	0	1,303	UT	1,252	4	20	0	1,276
MD	1,095	6	69	1	1,171	VA	1,190	4	63	2	1,259
ME	288	0	16	0	304	VI	99	0	0	0	99
MI	2,378	13	104	1	2,496	VT	122	0	3	0	125
MN	1,001	11	29	0	1,041	WA	1,489	3	25	0	1,517
MO	2,296	9	44	0	2,349	WI	899	5	64	0	968
MS	320	0	11	0	331	WV	210	0	56	0	266
MT	148	0	14	0	162	WY	100	0	8	0	108
					Total known[1]		**85,886**	**332**	**2,274**	**109**	**88,581**
					Foreign[2]		**2,093**	**10**	**9**	**0**	**2,112**
					Unknown		**8,667**	**25**	**24**	**2**	**8,718**
					Total		**96,626**	**367**	**2,307**	**111**	**99,411**

[1] Strikes were reported at 1,585 airports in the USA. The numbers include 1,358 bird strikes and 4 bat strikes that occurred enroute where the state where the strike occurred was reported.

[2] Strikes to USA air carriers were reported at 237 foreign airports.

Table 8. Reported time of occurrence of wildlife strikes with civil aircraft, USA, 1990–2009[1].

	Birds		Terrestrial mammals	
Time of day	20-year total	% of total known	20-year total	% of total known
Dawn	2,564	4	45	3
Day	39,888	62	361	25
Dusk	3,166	5	128	9
Night	18,385	29	897	63
Total known	**64,003**	**100**	**1,431**	**100**
Unknown	**32,623**		**876**	
Total	**96,626**		**2,307**	

[1] In addition, 367 strikes with bats were reported from 1990–2009: time not reported (269), night (76), dusk (9), day (11), and dawn (2). Also, 111 strikes with reptiles were reported from 1990–2009: time not reported (93), day (11), night (4), dusk (2), and dawn (1).

Table 9. Reported phase of flight at time of occurrence of wildlife strikes with civil aircraft, USA, 1990–2009[1].

	Birds		Terrestrial mammals	
Phase of flight	20-year total	% of total known	20-year total	% of total known
Parked	42	<1	1	<1
Taxi	258	<1	39	2
Take-off Run	13,313	19	506	32
Climb	12,579	18	35	2
En Route	1,674	2	0	0
Descent	2,615	4	0	0
Approach	27,605	40	107	7
Landing Roll	11,690	17	882	56
Total known	**69,776**	**100**	**1,570**	**100**
Unknown	**26,850**		**737**	
Total	**96,626**		**2,307**	

[1] In addition, 367 strikes with bats were reported from 1990-2009: phase of flight not reported (275), approach (59), landing roll (11), climb (10), descent (5), take-off run (4), and en route (3). Also, 111 strikes with reptiles were reported: phase of flight not reported (85), take-off run (11), taxi (5), approach (5; pilot had a missed approach because reptile was on the runway), and landing roll (5).

Table 10. Number of reported bird strikes to commercial civil aircraft by height (feet) above ground level (AGL), USA, 1990–2009. See Figure 5 for graphic analysis of strike data from 500 to 18,500 feet AGL[1].

Height of strike (feet AGL)	All reported strikes			Strikes with damage		
	20-year total	% of total known	% cum-ulative total	20-year total	% of total known	% cum-ulative total
0	21,070	41	41	1,455	30	30
1-500	15,603	31	72	1,355	28	58
501-1500	5,351	11	82	682	14	72
1501-2500	2,712	5	88	418	9	81
2501-3500	2,035	4	92	266	6	86
3501-4500	1,204	2	94	152	3	90
4501-5500	881	2	96	120	2	92
5501-6500	630	1	97	96	2	94
6501-7500	402	1	98	61	1	95
7501-8500	324	1	99	60	1	97
8501-9500	176	<1	99	26	1	97
9501-10,500	220	<1	99	40	1	98
>10,500	333	<1	100	101	2	100
Total known	**50,941**	**100**		**4,832**	**100**	
Unknown height	**17,526**			**2,120**		
Total	**68,467**			**6,952**		

[1] A more detailed analysis of bird strikes by height AGL is provided by Dolbeer (2006*b*).

Table 11. Number of reported bird strikes to general aviation aircraft by height (feet) above ground level (AGL), USA, 1990–2009. See Figure 5 for graphic analysis of strike data from 500 to 18,500 feet AGL[1].

Height of strike (feet AGL)	All reported strikes			Strikes with damage		
	20-year total	% of total known	% cum-ulative total	20-year total	% of total known	% cum-ulative total
0	4,280	40	40	549	19	19
1-500	3,918	37	76	967	34	54
501-1500	1,313	12	89	677	24	77
1501-2500	592	6	94	308	11	88
2501-3500	277	3	97	153	5	94
3501-4500	133	1	98	69	2	96
4501-5500	75	1	99	37	1	97
5501-6500	46	<1	99	22	1	98
6501-7500	37	<1	99	16	1	99
7501-8500	14	<1	100	4	<1	99
8501-9500	12	<1	100	7	<1	99
9501-10,500	11	<1	100	7	<1	99
>10,500	24	<1	100	16	<1	100
Total known	**10,732**	**100**		**2,832**	**100**	
Unknown height	**17,427**			**401**		
Total	**28,159**			**3,233**		

Table 12. Civil aircraft components reported as being struck and damaged by wildlife, USA, 1990–2009.

	Birds (20-year total)				Terrestrial mammals (20-year total)			
Aircraft component	Number struck	% of total	Number damaged	% of total	Number struck	% of total	Number damaged	% of total
Windshield	14,843	17	711	6	7	<1	14	1
Engine(s)[1]	12,493	14	3,757	31	155	8	159	10
Nose	12,601	14	727	6	87	4	86	5
Wing/rotor	11,659	13	2,754	23	230	11	242	15
Fuselage	11,077	13	472	4	114	6	125	8
Radome	10,987	12	1,179	10	13	1	14	1
Other	6,719	8	913	8	287	14	256	16
Landing gear	3,960	4	385	3	815	40	379	23
Propeller	2,217	3	214	2	267	13	259	16
Tail	1,179	1	484	4	53	3	68	4
Light	635	1	491	4	33	2	40	2
Total[2]	**88,370**	**100**	**12,087**	**100**	**2,061**	**100**	**1,642**	**100**

[1] For birds, 12,493 engines were reported as struck in 11,907 strike events involving engines (11,343 events with one engine struck, 547 with two engines struck, 12 with three engines struck, and 5 with four engines struck). A total of 3,757 engines were damaged in 3,638 bird strike events with engine damage (3,522 events with one engine damaged, 114 with two engines damaged, 1 with three engines damaged, and 1 with 4 engines damaged). For terrestrial mammals, 155 engines were reported as struck in 145 strike events (135 events with one engine struck and 10 with two engines struck). A total of 159 engines were damaged in 141 terrestrial mammal strike events with engine damage (123 events with one engine damaged and 18 with two engines damaged). Some engines were damaged without being struck when the landing gear collapsed.

[2] In addition, bat strikes had 123 and 7 components reported as struck and damaged, respectively: radome/nose (37, 0), windshield (26, 0), engine (12, 3), propeller (1, 0), wing/rotor (18, 3), fuselage (10, 0), tail (2, 0), other (11, 0), landing gear (5, 0), light (1, 1). For reptile strikes, there were 21 and 5 components reported struck and damaged, respectively: windshield (1, 1), wing/rotor (1, 1), fuselage (1, 1), landing gear (16, 0); tail (1, 1), other (1, 1).

Table 13. Number of civil aircraft with reported damage resulting from wildlife strikes, USA, 1990–2009. See Tables 1, 2, and 3 and Figure 5 for trends in damaging strikes from 1990–2009.

	Reported strikes					
	Birds		Terrestrial mammals		Total[1]	
Damage category[2]	20-year total	% of total known	20-year total	% of total known	20-year total	% of total known
None	**64,670**	**86**	**582**	**39**	**65,375**	**85**
Damage	**10,185**	**14**	**917**	**61**	**11,110**	**15**
Minor	5,407	7	484	32	5,894	8
Uncertain	2,178	3	61	4	2,240	3
Substantial	2,569	3	348	23	2,921	4
Destroyed	31	<1	24	2	55	0
Total known	**74,855**	**100**	**1,499**	**100**	**76,485**	**100**
Unknown	**21,771**		**808**		**22,926**	
Total	**96,626**		**2,307**		**99,411**	

[1] Included in totals are 367 and 111 strikes involving bats and reptiles, respectively. For bats, 107 reports indicated no damage, 253 failed to report if damage occurred, 3 reported minor damage, 1 reported uncertain level of damage, and 3 reported substantial damage. For reptiles, 16 reports indicated no damage, 94 failed to report if damage occurred, and 1 reported substantial damage.

[2] The damage codes and descriptions follow the *International Civil Aviation Organization Bird Strike Information System (1989):* Minor = the aircraft can be rendered airworthy by simple repairs or replacements and an extensive inspection is not necessary; Uncertain = the aircraft was damaged, but details as to the extent of the damage are lacking; Substantial = the aircraft incurs damage or structural failure that adversely affects the structure strength, performance, or flight characteristics of the aircraft and that would normally require major repair or replacement of the affected component (specifically excluded are bent fairings or cowlings; small dents or puncture holes in the skin; damage to wing tips, antenna, tires, or brakes; and engine blade damage not requiring blade replacement); Destroyed = the damage sustained makes it inadvisable to restore the aircraft to an airworthy condition.

Table 14. Reported effect-on-flight (EOF) of wildlife strikes to civil aircraft, USA, 1990–2009.

	Reported strikes					
	Birds		Terrestrial mammals		Total[1]	
Effect-on-flight[2]	20-year total	% of total known	20-year total	% of total known	20-year total	% of total known
None	**51,278**	**88**	**538**	**47**	**51,926**	**87**
Negative effect	**6,879**	**12**	**599**	**53**	**7,489**	**13**
Precautionary landing	3,555	6	90	8	3,649	6
Aborted take-off	1,602	3	194	17	1,796	3
Engine shutdown	335	1	27	2	362	1
Other	1,387	2	288	25	1,682	3
Total known	**58,157**	**100**	**1,137**	**100**	**59,415**	**100**
Unknown	**38,469**		**1,170**		**39,996**	
Total	**96,626**		**2,307**		**99,411**	

[1] Included in totals are 367 and 111 strikes involving bats and reptiles, respectively. For bats, 90 reports indicated no effect-on-flight, 274 failed to report if an effect-on-flight occurred, and 3 reported a precautionary landing. For reptiles, 20 reports indicated no effect-on-flight, 83 failed to report if an effect-on-flight occurred, 1 reported a precautionary landing, and 7 reported “other”.

[2] Effect-on-flight: None = flight continued as scheduled, although delays and other cost caused by inspections or repairs may have been incurred after landing; Aborted take-off = pilot aborted the take-off; Precautionary landing = pilot landed at other-than-destination airport after strike; Engine shut down = pilot shut down the engine or the engine stopped running because of strike; Other = miscellaneous effects, such as reduced speed because of shattered windshield, emergency landing at other-than-destination airport, flight delays, or crash landing; Unknown = report did not give sufficient information to determine an effect-on-flight (Dolbeer et al. 2000).

Table 15. Total reported strikes, strikes causing damage, strikes having a negative effect-on-flight (EOF), strikes involving >1 animal, aircraft downtime, and costs by identified wildlife species for civil aircraft, USA, 1990–2009 (page 1 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Birds						
Loons	**22**	**14**	**9**	**0**	**2,885**	**1,766,200**
Loons	3	3	2		557	251,200
Common loon	18	10	6		2,280	1,513,000
Red-throated loon	1	1	1		48	2,000
Grebes	**48**	**10**	**7**	**8**	**168**	**2,109,470**
Grebes	8	1		1		
Eared grebe	6	1		1	10	100,000
Western grebe	15	6	5	6	86	1,900,000
Pied-billed grebe	10		1			0
Horned grebe	6	2	1		72	109,470
Red-necked grebe	2					
Clark's grebe	1					
Albatrosses/shearwaters	**54**	**7**	**6**		**149**	**62,500**
Laysan albatross	31	6	5		149	62,500
Black-footed albatross	5	1				
Bonin petrel	3					
Wedge-tailed shearwater	9		1			
Townsend's shearwater	5					
Fork-tailed storm-petrel	1					
Tropicbirds	**12**	**8**	**7**		**172**	**75,300**
Tropicbirds	6	5	4		124	40,200
White-tailed tropicbird	3	2	2		48	29,500
Red-tailed tropicbird	3	1	1			5,600
Pelicans	**61**	**30**	**25**	**8**	**479**	**2,516,523**
Pelicans	4	2			80	
Australian pelican	1	1	1			
Brown pelican	48	22	18	5	327	266,523
American white pelican	8	5	6	3	72	2,250,000
Red- footed booby	**1**					
Cormorants	**83**	**30**	**19**	**11**	**282**	**2,984,722**
Cormorants	8	2	2			180,000
Great cormorant	2	1		2		
D.-crested cormorant	72	27	17	9	282	2,804,722
Pelagic cormorant	1					
Anhinga	**18**	**7**	**7**	**3**	**117**	**7,800**

Table 15. Continued (page 2 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Frigatebirds	**12**	**5**	**2**		**21**	**18,400**
Frigatebirds	3	2	1		18	13,500
Great frigatebird	7	2	1		3	4,900
Magnificent frigatebird	2	1	0			
Herons/bitterns	**397**	**75**	**57**	**15**	**3,491**	**5,175,396**
Herons	49	13	9	4	99	3,200
Gray heron	1	1	1			
Great blue heron	235	51	41	6	2,679	4,829,810
Blk-crowned night-heron	37	4	2	2	49	281,200
Little blue heron	4					
Green heron	7					
Yell.-crowned night heron	12	3	2	1	18	17,000
Tricolored heron	1					
American bittern	6	3	2		646	44,186
Yellow bittern	45			2		
Egrets	**536**	**60**	**80**	**133**	**3,805**	**5,329,697**
Egrets	279	31	42	79	3,467	3,465,140
Cattle egret	189	19	30	46	178	12,775
Great egret	44	8	7	7	134	1,851,782
Snowy egret	24	2	1	1	26	
Storks	**11**	**4**	**2**	**2**	**24**	**20,000**
White stork	1	1				
Wood stork	10	3	2	2	24	20,000
Ibises/spoonbills	**21**	**5**	**5**	**5**	**1**	
Ibises	5		1	1		
Glossy ibis	1			1		
White ibis	6	1	1	1		
White-faced ibis	8	4	2	2		
Roseate spoonbill	1		1		1	
Waterfowl	**3,391**	**1,503**	**744**	**1,238**	**121,553**	**144,074,372**
Ducks, geese, swans	134	64	31	54	763	847,075
Ducks	689	238	114	227	5,270	4,060,096
American wigeon	30	15	6	9	3,951	1,083,089
Northern pintail	60	38	21	33	1,509	1,869,439
Green-winged teal	25	10	6	9	732	688,142
Blue-winged teal	15	8	3	8	145	608,440
Eurasian wigeon	1			1		
Mallard	521	129	63	117	9,253	5,399,639

Table 15. Continued (page 3 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Common eider	3	2	1	1		
Ring-necked duck	10	5	3	4	1,080	78,468
Greater scaup	4	1	1	1		
Wood duck	25	9	4	6	294	85,704
Muscovy duck	1	1			120	443,332
Common goldeneye	3	2	1			2,000
Red-breasted merganser	4	1		1	2	
Hooded merganser	5	2		1	30	27,023
Common merganser	2	2	2	1	120	2,500
Northern shoveler	28	14	3	12	1,668	1,340,020
Gadwall	22	6	3	5	414	1,521,678
Canvasback	11	4	1	4	335	2,154,077
American black duck	31	3	1	11	36	1,500
Mottled duck	14	4	3	3	24	
Lesser scaup	20	12	7	8	1,263	165,000
Ruddy duck	17	5	1		24	8,446
Redhead	3	1		1		
Bufflehead	5	1	1	1	40	4,874
Long-tailed duck	3	2	2	1	3	1,100
Philippine duck	1	1	1	1	96	9,456,000
Blk-bellied whistling-duck	1					
Cinnamon teal	3				8	
White-winged scoter	1	1	1	1	1,400	430,000
Hawaiian duck	2					
Geese	320	195	83	112	24,424	2,000,117
Snow goose	90	71	35	49	7,589	20,245,986
Canada goose	1,238	630	336	535	60,152	88,904,019
Brant	20	9	3	7	108	51,271
Gr white-fronted goose	14	10	3	9	292	1,500,547
Emperor goose	1					
Swans	2	1				
Mute swan	5			1		
Tundra swan	5	4	2	3	336	144,790
Trumpeter swan	2	2	2	1	72	950,000
Raptors	**5,724**	**925**	**632**	**219**	**87,547**	**55,982,962**
Hawks, eagles, vultures	29	16	7	1	2,559	17,550
Vultures	268	154	76	27	22,619	9,312,759
Black vulture	53	32	22	6	5,261	1,458,658

Table 15. Continued (page 4 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Turkey vulture	363	185	126	18	23,995	4,532,437
Osprey	168	37	25	3	2,268	292,923
White-tailed kite	14	4	2		46	5,000,000
Black kite	2	1	1			
Mississippi kite	1					
Swallow-tailed kite	1					
Eagles	7	3	2	1		
Bald eagle	125	53	36	9	6,340	14,402,681
White-breasted sea-eagle	1	1	1			
Golden eagle	8	2	4		3,696	801,000
Hawks	1,041	205	145	28	9,871	4,009,818
Northern goshawk	1					
Red-tailed hawk	1,122	182	127	26	9,078	6,709,526
Rough-legged hawk	40	2	2			167
Red-shouldered hawk	15	1	2		41	900
Swainson's hawk	53	5	4	1	16	350,000
Sharp-shinned hawk	11					
Cooper's hawk	39	2	2		3	
Ferruginous hawk	9	1	1		24	3,200,000
Broad-winged hawk	9	1		1		
Harris' hawk	2					
White-tailed hawk	1					
Eurasian buzzard	1				24	
Northern harrier	70	2	1	2		200,000
Lappet-faced vulture	1	1	1		240	4,000,000
Falcons	41	3	4	1	81	30,100
Peregrine falcon	149	10	3	6	78	235,500
Gyrfalcon	1					
Merlin	40		2	1	3	130
Crested caracara	6	2	1		2	
Prairie falcon	9					
American kestrel	2,019	19	34	88	1,302	1,428,813
Eurasian kestrel	4	1	1			
Gallinaceous birds	**160**	**44**	**35**	**28**	**1,830**	**620,287**
Grouse	7	2		3	2	
Greater sage-grouse	6	4	4	1	337	256,077
Sharp-tailed grouse	1	1	1		24	500
Ptarmigans	6	4	1	2	57	57,500

Table 15. Continued (page 5 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Black francolin	3					
Quails	10		2	2		
Northern bobwhite	6	2	3	1	73	800
Scaled quail	3					
Pheasants	1	1				
Ring-necked pheasant	60	14	10	5	863	92,000
Partridges	1					
Red-legged partridge	1					
Gray partridge	5	2	1	3	24	120
Chukar	2		1	1		
Gray francolin	2					
Guineafowl	1	1		1		
Wild turkey	45	13	12	9	450	213,290
Cranes	**101**	**39**	**29**	**33**	**2,413**	**434,560**
Cranes	12	3	5	2	31	250,000
Sandhill crane	88	35	24	31	2,334	134,260
Whooping crane	1	1			48	50,300
Rails/gallinules	**98**	**20**	**9**	**6**	**1,993**	**1,001,426**
Rails	3	1	1	1		
Sora	10		1		20	
Common moorhen	3	1	1		24	990
American coot	72	17	5	5	1,877	974,986
Purple gallinule	3	1	1		72	25,450
Virginia rail	3					
Clapper rail	4					
Shorebirds	**3,158**	**84**	**110**	**514**	**1,477**	**3,420,818**
Shorebirds	19			9		
American oystercatcher	18			2		
Plovers, lapwings	1			1		
Plovers	42	3	4	8	24	
European golden-plover	3					
American golden-plover	62	3	4	21	16	2,000
Black-bellied plover	49	4	3	8	20	164,254
Snowy plover	1			1		
Killdeer	1,823	35	42	185	340	2,636,463
Pacific golden-plover	519	3	9	81	35	2,200
Semipalmated plover	32			13		
Wilson's plover	1					

Table 15. Continued (page 6 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Northern lapwing	1	1	1	1	25	
Southern lapwing	1	1	1			8,000
Sandpipers	180	11	22	69	169	106,560
Upland sandpiper	106	4	6	12	12	1,000
Spotted sandpiper	9	1		3		
Willet	5			2		
Wilson's snipe	31	3	2	4	19	12,615
American woodcock	29	1	2	3		
Dunlin	17	3	2	5	504	205,300
Baird's sandpiper	11			1		
Western sandpiper	43	2	3	28	93	106,566
Pectoral sandpiper	7	1	1	2		300
Sanderling	16	1	2	8		
Buff-breasted sandpiper	13			4		
Ruddy turnstone	5			1		
Least sandpiper	34	1	3	14	3	
Semipalmated sandpiper	28			12		
Lesser yellowlegs	3			1		
Short-billed dowitcher	5	1		1		
Hudsonian godwit	1	1	1	1	96	23,495
Solitary sandpiper	2			1		
Greater yellowlegs	2	1			48	8,000
Long-billed dowitcher	6			2	1	
Red knot	2					
White-rumped sandpiper	4					
Black turnstone	1					
Marbled godwit	1	1	1	1	48	144,065
Curlews	1			1		
Eurasian curlew	1					
Whimbrel	9	1	1	1	24	
Long-billed curlew	3					
Red-necked phalarope	2					
Wilson's phalarope	1			1		
American avocet	4	1		3		
Black-necked stilt	4			3		
Gulls/jaegers	**7,894**	**1,204**	**980**	**1,862**	**53,437**	**36,241,330**
Parasitic jaeger	1					

Table 15. Continued (page 7 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Gulls	5,576	968	766	1,477	39,424	19,168,196
Herring gull	776	84	79	92	1,940	1,710,951
Mew gull	46	6	4	8	28	86,717
Ring-billed gull	894	85	75	178	5,536	2,991,930
Glaucous-winged gull	59	12	8	10	290	346,545
Great black-backed gull	72	7	5	4	27	250,000
Franklin's gull	56	3	6	22	19	139,000
Laughing gull	244	16	18	41	731	534,136
Bonaparte's gull	27	2	3	7		65,000
Lesser black-backed gull	3	1	1	1		
Western gull	67	9	5	8	126	680,857
California gull	60	8	7	8	4,860	361,948
Heermann's gull	1			1		
Black-headed gull	2					
Thayer's gull	3					
Yellow-legged gull	3	3	3	3	456	9,906,050
Glaucous gull	4			2		
Terns/kittiwakes	**117**	**4**	**3**	**26**	**4**	
Terns	38	2		12		
Caspian tern	18			1		
Common tern	12			2		
Gull-billed tern	3					
Fairy tern	2					
White tern	3		1	1		
Arctic tern	3	1		2		
Roseate tern	1					
Forster's tern	8		1	2	4	
Least tern	7			2		
Black noddy	3			2		
Brown noddy	6		1	1		
Royal tern	2					
Sooty tern	1					
Black-legged kittiwake	2					
Red-legged kittiwake	1					
Black skimmer	7	1		1		
Pigeons/doves	**6,410**	**363**	**431**	**1,574**	**22,661**	**11,282,378**
Pigeons, doves	14	1	1	10	24	400
Pigeons	16	2	2	6	9	300

Table 15. Continued (page 8 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Common wood-pigeon	3					
Band-tailed pigeon	4	1		2	16	
Doves	922	45	77	248	1,175	295,610
Rock pigeon	1,782	199	180	622	14,060	5,208,449
Mourning dove	3,408	109	162	666	7,169	5,503,214
Spotted dove	95	3	6	5	133	274,405
Zebra dove	121	2	3	15	3	
Inca dove	14					
Island turtle dove	4					
White-winged dove	20	1			72	
Common ground-dove	7					
Parrots	**14**			**1**		
Parrots	6			1		
Budgerigar	7					
Nanday parakeet	1					
Cuckoos/roadrunners	**14**	**1**		**3**		
Cuckoos	2			1		
Yellow-billed cuckoo	10	1		2		
Common cuckoo	1					
Greater roadrunner	1					
Owls	**1,306**	**90**	**56**	**10**	**1,545**	**5,596,892**
Owls	265	29	15	4	960	296,875
Barn owl	558	26	19	4	248	1,900,310
Snowy owl	66	6	6		84	331,053
Short-eared owl	213	7	7		58	1,268,171
Long-eared owl	8	2	1			
Northern saw-whet owl	4					
Burrowing owl	76	1		1	1	
Barred owl	10	1	1			
Northern pygmy-owl	1					
Eastern screech-owl	3	2			24	7,558
Western screech-owl	2					
Great horned owl	100	16	7	1	170	1,792,925
Nightjars	**213**	**2**		**14**		
Nightjars	6	1				
Whip-poor-will	2					
Common poorwill	7					
Lesser nighthawk	6					

Table 15. Continued (page 9 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Chuck-will's-widow	2					
Common nighthawk	190	1		14		
Swifts	**140**	**5**	**3**	**11**	**26**	
Swifts	10	1		2		
Chimney swift	104	2	3	9	1	
Common swift	1	1				
Vaux's swift	14				24	
White-throated swift	11	1			1	
Hummingbirds	**6**					
Hummingbirds	2					
R.-throated hummingbird	1					
Anna's hummingbird	2					
Blk-chinned hummingbird	1					
Belted kingfisher	**8**					
Woodpeckers	**60**	**3**	**4**	**2**	**1**	**15,000**
Woodpeckers	9		1			
Northern flicker	38	3				
Yellow-bellied sapsucker	8		1	2		
Hairy woodpecker	3					
Red-naped sapsucker	1		1			15,000
Downy woodpecker	1		1		1	
Unidentified passiformes	**122**	**9**	**3**	**16**	**66**	**91,405**
Flycatchers	**162**	**1**	**4**	**9**	**1**	**9,800**
Tyrant flycatchers	12			1	1	
Eastern wood-pewee	3					
Great crested flycatcher	1					
Eastern kingbird	10	1	1			9,800
Scissor-tailed flycatcher	55		2	4		
Acadian flycatcher	1					
Say's phoebe	3					
Western kingbird	69		1	3		
Ash-throated flycatcher	1					
Western wood-pewee	1					
Sulphur-bellied flycatcher	1					
Eastern phoebe	1					
Yellow-bellied flycatcher	1			1		
Least flycatcher	2					
Hammond's flycatcher	1					

Table 15. Continued (page 10 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Larks	**1,136**	**13**	**21**	**263**	**74**	**510,729**
Larks	8			3		
Sky lark	28			1		
Horned lark	1,100	13	21	259	74	510,729
Swallows	**2,424**	**20**	**50**	**561**	**173**	**37,714**
Swallows	565	6	26	177	32	
Purple martin	84	2	1	22	3	
Bank swallow	109	2	4	46	5	
Barn swallow	1,070	7	13	190	117	23,907
Cliff swallow	376	3	3	61	11	13,742
Tree swallow	192		3	63	5	65
Violet-green swallow	10			1		
N. rough-winged swallow	17					
Cave swallow	1			1		
Starlings/mynas	**2,377**	**96**	**132**	**909**	**2,250**	**4,345,705**
European starling	2,330	95	131	896	2,246	4,345,705
Mynas	4			2		
Common myna	43	1	1	11	4	
Crows/ravens	**509**	**54**	**46**	**74**	**6,609**	**1,477,603**
Crows	228	25	22	35	906	144,000
American crow	248	21	19	36	5,562	1,265,113
Carrion crow	1					
Hooded crow	1	1	1			
Northwestern crow	3			1		
Common raven	28	7	4	2	141	68,490
Jays/magpies	**25**	**2**	**2**	**4**	**1**	**555**
Blue jay	9					
Yellow-billed magpie	8			2		
Black-billed magpie	8	2	2	2	1	555
Chickadees	**24**	**1**		**7**		
Chickadees	5	1		2		
Black-capped chickadee	15			2		
Mountain chickadee	2			2		
Gray-headed chickadee	1			1		
Carolina chickadee	1					
Red-vented bulbul	**2**			**1**		
Wrens	**61**	**1**	**2**	**9**		
Wrens	43	1	1	9		

Table 15. Continued (page 11 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Marsh wren	4		1			
House wren	7					
Carolina wren	2					
Rock wren	1					
Cactus wren	3					
Winter wren	1					
Mimics	**84**	**1**	**2**	**3**		**120**
Brown thrasher	9					120
Curve-billed thrasher	1					
Northern mockingbird	47	1	2			
Tropical mockingbird	1					
Gray catbird	26			3		
Thrushes	**424**	**33**	**24**	**37**	**1,647**	**2,369,647**
Thrushes	16	2	1	1	7	25,500
Western bluebird	2				3	
Swainson's thrush	19	3	1	2	26	2,002,025
Redwing	1					
American robin	339	23	18	29	1,582	322,137
Hermit thrush	14	1		1	22	3,800
Eastern bluebird	4					
Mountain bluebird	5			2		
Gray-cheeked thrush	3					
Varied thrush	15	4	2	1	7	15,905
Wood thrush	5		1	1		280
Veery	1		1			
Kinglets	**9**			**1**		
Golden-crowned kinglet	2					
Ruby-crowned kinglet	7			1		
Wrentits/gnatcatchers	**2**					
Wrentit	1					
Blue-gray gnatcatcher	1					
American pipit	**18**			**3**		
Waxwings	**25**		**1**	**6**	**4**	
Bohemian waxwing	1			1		
Cedar waxwing	24		1	5	4	
Loggerhead shrike	**7**		**1**			
Vireos	**17**	**1**		**2**		
Vireos	3					
Yellow-throated vireo	1					

Table 15. Continued (page 12 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Warbling vireo	5			1		
Red-eyed vireo	7	1		1		
Cassin's vireo	1					
Japanese white-eye	**1**					
Warblers	**134**	**3**	**5**	**9**	**31**	**6,612**
Wood warblers	27	1		2		1,700
Canada warbler	3					
Yellow-breasted chat	4					
Pine warbler	3					
Black-and-white warbler	4					
Northern parula	3					
Ovenbird	8	1	2		1	100
Wilson's warbler	11			1	4	4,569
Common yellowthroat	9		1		1	
Yellow-rumped warbler	15			2		43
Blackpoll warbler	6			2	1	200
Mourning warbler	1					
American redstart	1				3	
Orange-crowned warbler	2					
Yellow warbler	5	1		1	17	
Northern waterthrush	3					
Nashville warbler	7		1	1		
Townsend's warbler	2					
Palm warbler	5					
Magnolia warbler	5		1		2	
Blk-throated blue warbler	2					
Prothonotary warbler	1					
MacGillivray's warbler	2					
Yellow-throated warbler	3					
Blk-throated gray warbler	1				2	
Blk-throated grn warbler	1					
Meadowlarks	**1,120**	**12**	**24**	**124**	**237**	**266,452**
Meadowlarks	288	2	7	26	14	
Eastern meadowlark	480	3	7	43	7	
Western meadowlark	352	7	10	55	216	266,452
Blackbirds/orioles	**1,496**	**93**	**102**	**410**	**1,472**	**1,047,802**
Blackbirds	1,074	74	79	325	588	863,897

Table 15. Continued (page 13 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Red-winged blackbird	101	3	6	13	7	750
Yellow-headed blackbird	6	1	1	1		
Brewer's blackbird	29			3		
Brown-headed cowbird	86	2	3	29	11	5,155
Bobolink	9		1			
Rusty blackbird	1					
Orioles	5					
Baltimore oriole	6		1	1		
Orchard oriole	1					
Bullock's oriole	1					
Grackles	80	6	2	20	720	133,000
Common grackle	72	5	7	16	123	45,000
Boat-tailed grackle	6	1	1		20	
Great-tailed grackle	12			2		
Scarlet tanager	3	1				
Western tanager	4		1		3	
Finches	**341**	**6**	**24**	**129**	**83**	**10,000**
Finches	59	1	5	16	4	
Lapland longspur	8			3		
Chtnut-collared longspur	1					
Dark-eyed junco	24	2	2	3	49	9,000
Rose-breasted grosbeak	2					
Island canary	1					
Pine siskin	3			2	1	
Tropical mockingbird	1					
Purple finch	2					
Evening grosbeak	1					
American goldfinch	26		1	1	3	
House finch	38			4		
Smith's longspur	1					
Dickcissel	3			1		
White-winged crossbill	1					
Red avadavat	2			1		
McCown's longspur	1					
Lesser goldfinch	1					
Red-crested cardinal	4			1	1	
Northern cardinal	3					
Snow bunting	133	2	16	92	23	1,000
Indigo bunting	1					

Table 15. Continued (page 14 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Lazuli bunting	1					
Lark bunting	25	1		5	2	
Sparrows	**2,602**	**47**	**96**	**624**	**611**	**85,640**
Sparrows	2,315	43	94	598	598	50,440
Harris's sparrow	1					
Swamp sparrow	7					
Savannah sparrow	118	1		11	5	1,000
Fox sparrow	11	1				4,100
White-throated sparrow	21	1	1	2		
Golden-crowned sparrow	3			1		
Field sparrow	14					
Lark sparrow	8					
White-crowned sparrow	9					
Grasshopper sparrow	17	1	1	1	4	29,700
Java sparrow	2			1		
Vesper sparrow	9			1		
Chipping sparrow	12			2		
Lincoln's sparrow	6					
Song sparrow	36			7	3	400
Sage sparrow	5				1	
American tree sparrow	7					
Black-throated sparrow	1					
Towhees	**6**	**1**			**9**	**13,151**
Rufous-sided towhee	4	1			9	13,151
Green-tailed towhee	1					
California towhee	1					
Waxbills/mannikins	**115**	**0**	**2**	**54**	**10**	**3,600**
Waxbills, mannikins	2					
Common waxbill	3					
Mannikins	23			11		
Nutmeg mannikin	43		1	22	8	1,600
Black-headed munia	43		1	20	2	2,000
White-throated munia	1			1		
House sparrow	**77**	**2**	**1**	**11**	**2**	

Table 15. Continued (page 15 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Total known birds	**43,410**	**4,938**	**3,804**	**8,992**	**319,361**	**289,012,568**
Total unknown birds	**53,216**	**5,247**	**3,075**	**5,760**	**105,575**	**85,889,663**
Unknown bird - ? Size	24,200	2,652	1,314	1,521	29,460	30,346,696
Unknown bird-large	2,011	850	399	229	31,524	30,685,730
Unknown bird-medium	7,055	1,072	595	952	34,573	12,544,958
Unknown bird-small	19,950	673	767	3,058	10,018	12,312,279
Total birds[3]	**96,626**	**10,185**	**6,879**	**14,752**	**424,936**	**374,902,231**
Flying mammals (bats)						
Old world fruit bats	5	1	2	1	72	3,069,400
Vesper bats	3					
Red bat	19	1		1	1	
Hoary bat	3					
East. Small-footed myotis	1					
Little brown bat	20			1		
Big brown bat	4					
Silver-haired bat	3					
Free-tailed bats	9			1		270
Brazilian free-tailed bat	33		1			
Pocketed free-tailed bat	1					
Total known bats	**101**	**2**	**3**	**4**	**73**	**3,069,670**
Total unknown bats	**266**	**5**		**29**	**29**	**106,440**
Total bats[4]	**367**	**7**	**3**	**33**	**102**	**3,176,110**
Terrestrial mammals						
Marsupials (opossum)	**86**					
Xenarthyras (armadillo)	**21**	**1**	**4**		**10**	**1,000**
Lagomorphs	**290**	**7**	**8**	**5**	**20**	**104,484**
Hares	4					
Black-tailed jackrabbit	91	2	1			24,384
White-tailed jackrabbit	26			1	1	
Rabbits	122	2	3	4	13	2,100
Eastern cottontail	44	3	4		6	78,000
Desert cottontail	3					
Rodents	**150**	**2**	**2**	**4**	**3**	
Pocket gophers	2					
Squirrels	2					
Prairie dogs	5		1	1		
Black-tailed prairie dog	15					

Table 15. Continued (page 16 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Gunnison's prairie dog	11			3		
Woodchuck	89	2	1		3	
Woodrats	2					
Muskrat	13					
N. American porcupine	11					
Carnivores	**737**	**50**	**108**	**11**	**14,290**	**3,164,976**
Canids	3		1			
Coyote	321	29	72	5	11,680	2,776,040
Domestic dog	32	10	17	1	96	301,000
Foxes	72	4	7	1	10	750
Red fox	63	2	6		340	52,000
Common gray fox	4	1	1		2	186
Raccoon	63	3	3	2	2,160	35,000
White-nosed coati	1					
Ringtail	1					
Skunks	79		1	1	2	
Striped skunk	71			1		
River otter	2	1				
Badger	2					
Mink	1					
Domestic cat	19					
Small indian mongoose	3					
Artiodactyls	**1,003**	**847**	**467**	**83**	**242,919**	**36,379,187**
Deer	30	27	15		696	197,000
White-tailed deer	879	735	401	73	204,986	29,206,056
Mule deer	55	50	27	3	11,232	881,827
Wapiti (elk)	11	11	6	1	11,660	5,581,204
Moose	5	4	4			
Caribou	2	2	1			
Cattle	9	9	7	3	9,215	357,000
Pronghorn	9	8	5	2	5,130	156,100
Swine (pigs)	1					
Collared peccary	2	1	1	1		
Perissodactyls	**4**	**4**	**3**		**1,008**	**23,849**
Horse	3	3	3		1,008	23,849
Burro	1	1				
Total known t. mammals	**2,291**	**911**	**592**	**103**	**258,250**	**39,673,496**
Total unknown t. mammal	**16**	**6**	**7**	**1**		
Total terrestrial mammals[5]	**2,307**	**917**	**599**	**104**	**258,250**	**39,673,496**

Table 15. Continued (page 17 of 17).

Wildlife group or species	20-year totals					
	Number of reported strikes				Reported economic losses[1]	
	Total	With dam-age	With neg. EOF	With multiple animals[2]	Aircraft down time (hrs)	Reported costs ($)
Reptiles						
Turtles	**88**		**2**	**2**		
Turtles	52		2	1		
Florida soft shell turtle	4					
Eastern box turtle	5					
Common snapping turtle	3					
Diamondback terrapin	22			1		
Painted turtle	2					
American alligator	**15**	**1**	**2**		**3**	
Green iguana	**8**		**4**			
Total reptiles	**111**	**1**	**8**	**2**	**3**	
Total known (all species)	**45,913**	**5,852**	**4,407**	**9,101**	**577,687**	**331,755,734**
Total (unknown species)	**53,498**	**5,258**	**3,082**	**5,790**	**105,604**	**85,996,103**
Grand total	**99,411**	**11,110**	**7,489**	**14,891**	**683,291**	**417,751,837**

[1] These reported economic losses by species and species groups should be considered as relative indices of losses and not as actual estimated losses. For commercial aviation, an estimated 20 percent of strikes were reported in the 1990s and about 39 percent from 2004–2008. General aviation reporting rates are much lower than for commercial aviation. In addition, only about 45 percent of reported strikes identified the wildlife species or species group responsible, 1990–2009. Furthermore, less than 25 percent of reported strikes indicating damage also provided an estimate of the cost of damage or the downtime (see Table 19). Finally, even when cost estimates were provided, many reports were filed before aircraft damage had been fully assessed. See Table 19 for a more detailed projection of actual economic losses.

[2] More than one animal was struck by the aircraft.

[3] Of the 96,626 reported bird strikes, 43,410 (45 percent) identified the bird at least to species group. Of the 43,410 reports with birds identified to species group, 28,469 (66 percent) identified the bird to exact species (415 species total of which 186 caused damage). Thus, the bird was identified to species in 29 percent of the reported strikes, 1990–2009. Species identification has improved from less than 20 percent in the early 1990s to over 40 percent in 2008–2009 (Figure 7).

[4] Of the 367 reported bat strikes, 101 (28 percent) identified the bat at least to species group. Of the 101 reports with bats identified to species group, 84 (84 percent) identified the bat to exact species (8 species total of which 1 caused damage). Thus, the bat was identified to species in 23 percent of the reported strikes.

[5] Of the 2,307 reported terrestrial mammal strikes, 2,291 (99 percent) identified the mammal at least to species group. Of the 2,291 reports with mammals identified to species group, 1,970 (86 percent) identified the mammal to exact species (35 species total of which 20 caused damage). Thus, the mammal was identified to species in 85 percent of the reported strikes.

Table 16. Number of reported strikes, strikes with damage, and strikes involving multiple animals for the four most commonly struck bird groups and three most commonly struck terrestrial mammal groups, civil aircraft, USA, 1990–2009.

	Reported strikes		Strikes with damage		Strikes with >1 animal	
Species group[1]	20-year total	% of total known	20-year total	% of total known	20-year total	% of total known
Birds						
Gulls	7,894	18	1,204	24	1,862	21
Pigeons/ doves	6,410	15	363	7	1,574	18
Raptors	5,724	13	925	19	219	2
Waterfowl	3,391	8	1,503	30	1,238	14
All other known	19,991	46	943	19	4,099	46
Total known birds	**43,410**	**100**	**4,938**	**100**	**8,992**	**100**
Unknown birds	**53,216**		**5,247**		**5,760**	
Total birds	**96,626**		**10,185**		**14,752**	
Terrestrial mammals						
Artiodactyls	1,003	44	847	93	83	81
Carnivores	737	32	50	5	11	11
Lagomorphs	290	13	7	1	5	5
All other known	261	11	7	1	4	4
Total known t. mammals	**2,291**	**100**	**911**	**100**	**103**	**100**
Unknown t. mammals	**16**		**6**		**1**	
Total t. mammals	**2,307**		**917**		**104**	

[1] See Table 15 for listing of species within each species group.

Table 17. Bird and terrestrial mammal species with 25 or more reported strikes with civil aircraft in USA, 1990–2009 (Table 15), ranked by percent of strikes resulting in damage to aircraft (page 1 of 3)[1].

Rank	Wildlife species	Total reported strikes	Percent of strikes:		
			Causing damage	Causing negative EOF	Involving multiple animals
	Birds				
1	Snow goose	90	79	39	54
2	Northern pintail	60	63	35	55
3	Black vulture	53	60	42	11
4	Turkey vulture	363	51	35	5
4	Canada goose	1,238	51	27	43
5	American wigeon	30	50	20	30
5	Northern shoveler	28	50	11	43
6	Brown pelican	48	46	38	10
7	Bald eagle	125	42	29	7
8	Green-winged teal	25	40	24	36
8	Sandhill crane	88	40	27	35
9	Dbl.-crested cormorant	72	38	24	13
10	Wood duck	25	36	16	24
11	Wild turkey	45	29	27	20
12	Common raven	28	25	14	7
12	Mallard	521	25	12	23
13	American coot	72	24	7	7
14	Ring-necked pheasant	60	23	17	8
15	Osprey	168	22	15	2
15	Great blue heron	235	22	17	3
16	Glaucous-winged gull	59	20	14	17
17	Laysan albatross	31	19	16	0
18	Great egret	44	18	16	16
19	Red-tailed hawk	1,122	16	11	2
19	Great horned owl	100	16	7	1
20	Western gull	67	13	8	12
20	California gull	60	13	12	13
20	Mew gull	46	13	9	17
21	Rock pigeon	1,782	11	10	35
21	Blk-crowned night-heron	37	11	5	5
21	Herring gull	776	11	10	12
22	Cattle egret	189	10	16	24
22	Wilson's Snipe	30	10	7	13
22	American black duck	31	10	3	36
22	Great black-backed gull	72	10	7	6
22	Ring-billed gull	894	10	8	20
23	Swainson’s hawk	53	9	8	2
23	Snowy owl	66	9	9	0

Table 17. continued (page 2 of 3)

Rank	Wildlife species	Total reported strikes	Percent of strikes: Causing damage	Causing negative EOF	Involving multiple animals
	Birds (continued)				
23	American crow	248	9	8	15
24	Black-bellied plover	49	8	6	16
24	Northern flicker	38	8	0	0
25	Bonaparte's gull	27	7	11	26
25	Common grackle	72	7	10	22
25	American robin	339	7	5	9
25	Peregrine falcon	149	7	2	4
25	Laughing gull	244	7	7	17
25	Franklin's gull	56	5	11	39
25	Cooper's hawk	39	5	5	0
25	Rough-legged hawk	40	5	5	0
25	American golden-plover	62	5	7	34
25	Western sandpiper	43	5	7	65
25	Barn owl	558	5	3	1
26	European starling	2,330	4	6	39
26	Lark bunting	25	4	0	20
26	Upland sandpiper	106	4	6	11
27	American woodcock	29	3	7	10
27	Short-eared owl	213	3	3	0
27	Mourning dove	3,408	3	5	20
27	Spotted dove	95	3	6	5
27	Red-winged blackbird	101	3	6	13
27	Northern harrier	70	3	1	3
27	Least sandpiper	34	3	9	41
27	House sparrow	**77**	3	1	14
28	Purple martin	84	2	1	26
28	Common myna	43	2	2	26
28	Brown-headed cowbird	86	2	4	34
28	Northern mockingbird	47	2	4	0
28	Western meadowlark	352	2	3	16
28	Killdeer	1,823	2	2	10
28	Chimney swift	104	2	3	9
28	Bank swallow	109	2	4	42
28	Zebra dove	121	2	3	12
28	Snow bunting	133	2	12	69
29	Burrowing owl	76	1	0	1
29	Horned lark	1,100	1	2	24
29	American kestrel	2,019	1	2	4
29	Cliff swallow	376	1	1	16
29	Savannah sparrow	118	1	0	9
29	Barn swallow	1,070	1	1	18

Table 17. continued (page 3 of 3)

Rank	Wildlife species	Total reported strikes	Percent of strikes: Causing damage	Causing negative EOF	Involving multiple animals
	Birds (continued)				
29	Pacific golden-plover	519	1	2	16
29	Eastern meadowlark	480	1	2	9
29	Common nighthawk	190	1	0	7
30	Yellow bittern	45	0	0	4
30	Merlin	40	0	5	3
30	Semipalmated plover	32	0	0	41
30	Semipalmated sandpiper	28	0	0	43
30	Scissor-tailed flycatcher	55	0	4	7
30	Western kingbird	69	0	1	4
30	Sky lark	28	0	0	4
30	Tree swallow	192	0	2	33
30	Gray catbird	26	0	0	12
30	Brewer's blackbird	29	0	0	10
30	American goldfinch	26	0	4	4
30	House finch	38	0	0	11
30	Song sparrow	36	0	0	19
30	Nutmeg manikin	43	0	2	51
30	Black-headed munia	43	0	2	47
	Terrestrial mammals				
1	Mule deer	55	91	49	6
2	White-tailed deer	879	84	46	8
3	Domestic dog	32	31	53	3
4	Coyote	321	9	22	2
5	Eastern cottontail	44	7	9	0
6	Raccoon	63	5	5	3
7	Red fox	63	3	10	0
8	Woodchuck	89	2	1	0
8	Black-tailed jackrabbit	91	2	1	0
9	Opossum	86	0	0	0
9	White-tailed jackrabbit	26	0	0	4
9	Striped skunk	71	0	0	1

[1] See Dolbeer and Wright (2009) for a more detailed discussion of the use of wildlife strike data to rank species as to their hazard level to air operations and for use in airport Safety Management Systems.

Table 18. Number of civil aircraft lost (destroyed or damaged beyond repair) after striking wildlife by wildlife species and aircraft mass category, USA, 1990–2009[1].

Wildlife species or species group	Aircraft[2] mass category (Maximum take-off mass) ≤2,250 kg	2,251-5,700 kg	5,701-27,000 kg	>27,000 kg	Total aircraft lost
White-tailed deer	12	5	1		18
Unknown bird	10	1	1		12
Canada goose	1	3		1	5
Vultures[3]	3				3
Cattle	1	1			2
Hawks	2				2
Amer. white pelican		1			1
Bald eagle	1				1
Brown pelican	1				1
Cormorants	1				1
Coyote			1		1
Domestic dog	1				1
Ducks	1				1
Eastern cottontail	1				1
Eurasian kestrel				1	1
Mourning dove			1		1
Red-tailed hawk		1			1
Ring-billed gull		1			1
Wapiti (elk)			1		1
Total	**35**	**13**	**5**	**2**	**55**

[1] Thirty-three (60 percent) of the 55 wildlife strikes resulting in a destroyed aircraft occurred at General Aviation airports, 14 occurred away from an airport, 7 occurred at USA airports certificated for passenger service under 14 CFR Part 139, and 1 occurred at a foreign airport certificated for passenger service.

[2] Engine types on the 55 destroyed aircraft were piston (40), turbofan (6), turbojet (2), turboprop (5), and turboshaft (2). Aircraft operator was business (26), private (24), and commercial transport (5).

[3] Two turkey vultures and 1 unknown species of vulture (either turkey or black).

Table 19. Number of reported wildlife strikes indicating damage or a negative effect-on-flight (EOF) and reported losses in hours of downtime and U.S. dollars, for civil aircraft, USA, 1990–2009.

	Number of reports					Cost in millions of dollars ($) (Number of reports)		
	Total reports	Reports indicating adverse effect	Reports indicating aircraft damage	Reports indicating negative EOF	Reported time (hours) aircraft out of service (No. of reports)	Direct cost	Other cost	Total cost
20-yr total	99,411	16,518	11,110	7,489	683,291 (4,853)	372.724 (2,828)	45.028 (1,340)	417.752
20-yr avg.	4,971	826	556	374	34,165 (243)	18.636 (141)	2.251 (67)	20.887
Mean losses per incident reported					**140.8**	**0.132**	**0.034**	**0.166**
Estimated annual losses								
Minimum[1]					**116,285**	**108.852**	**27.752**	**136.604**
Maximum[2]					**581,424**	**544.259**	**138.762**	**683.021**

[1] Minimum values are based on the assumption that all 16,518 reported strikes indicating an adverse effect (negative EOF and/or damage) to aircraft (mean of 826/year) incurred similar amounts of damage and/or downtime and that these reports are all of the adverse-effect strikes that occurred, 1990–2009.

[2] Analyses of strike data from 1991–2004 indicated that 11 to 21 percent of strikes were reported for air carrier aircraft at Part 139 airports certificated for passenger traffic (Linnell et al. 1999, Cleary et al. 2005, Wright and Dolbeer 2005). Analyses of strike data from 2004–2008 indicated strike reporting at Part 139 airports had improved to 39 percent (Dolbeer 2009a). Strike reporting for General Aviation (GA) aircraft is estimated at less than 5 percent (Dolbeer et al. 2008, Dolbeer 2009a). Maximum values for reported losses are based on the assumption that the 16,518 reported strikes indicating an adverse effect represent, on average, 20 percent of the total strikes that occurred with commercial and GA aircraft from 1990–2009.

Figures

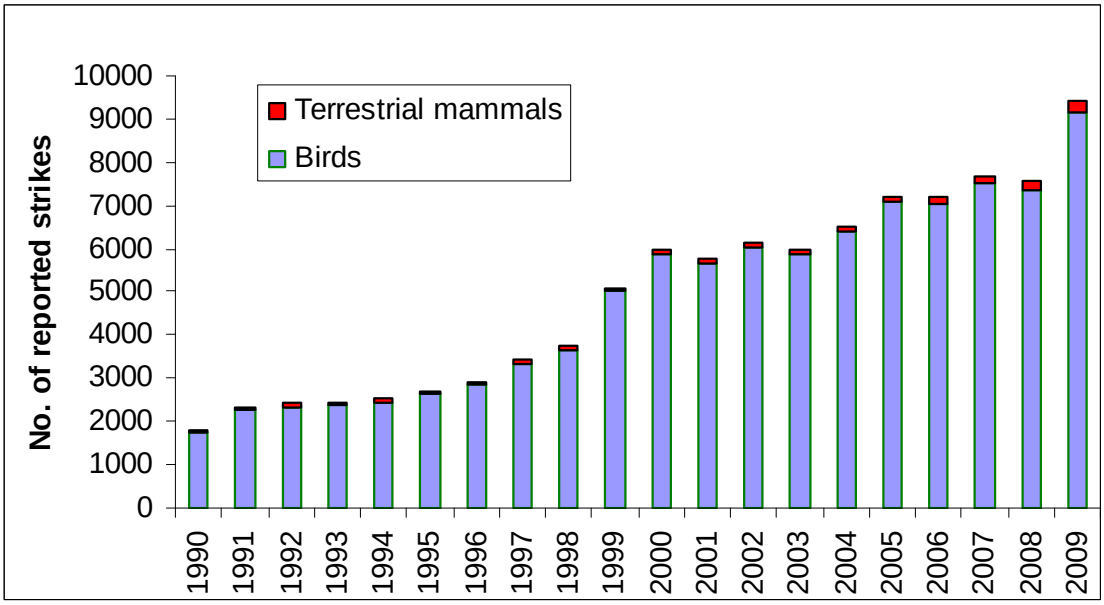


Figure 1. Number of reported bird (N = 96,626) and terrestrial mammal (N = 2,307) strikes to civil aircraft, USA, 1990–2009. Additionally, 367 and 111 strikes involving bats and reptiles, respectively, were reported for a total of 99,411 strikes by all species of wildlife (see Table 1).

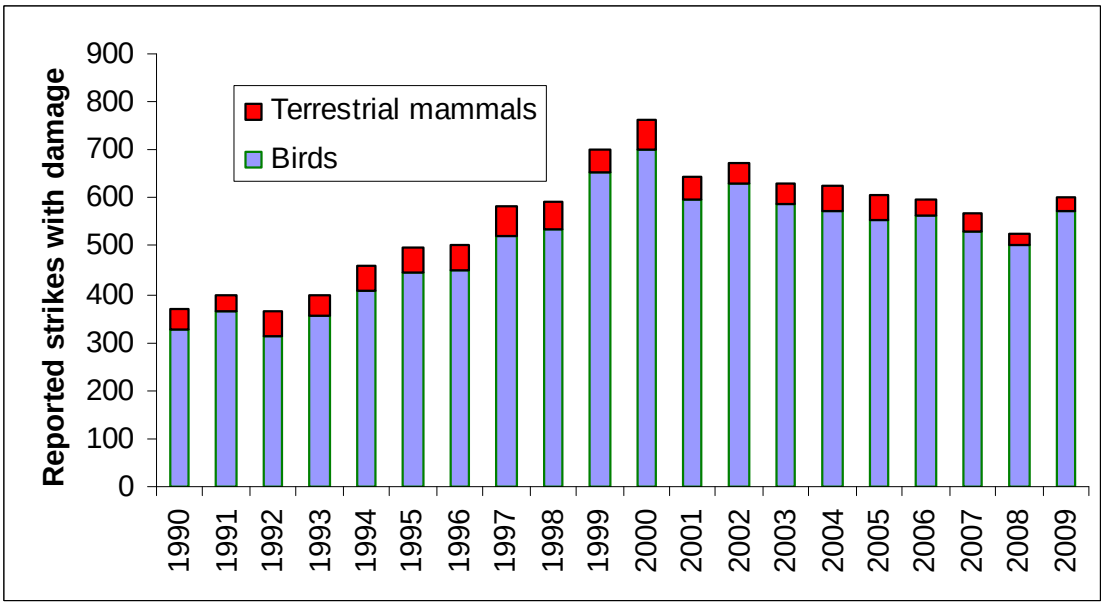


Figure 2. Number of reported bird (N = 10,185) and terrestrial mammal (N = 917) strikes causing damage to civil aircraft, USA, 1990–2009. Additionally, 7 and 1 damaging strikes involving bats and reptiles, respectively, were reported for a total of 11,110 damaging strikes by all species of wildlife (see Table 1).

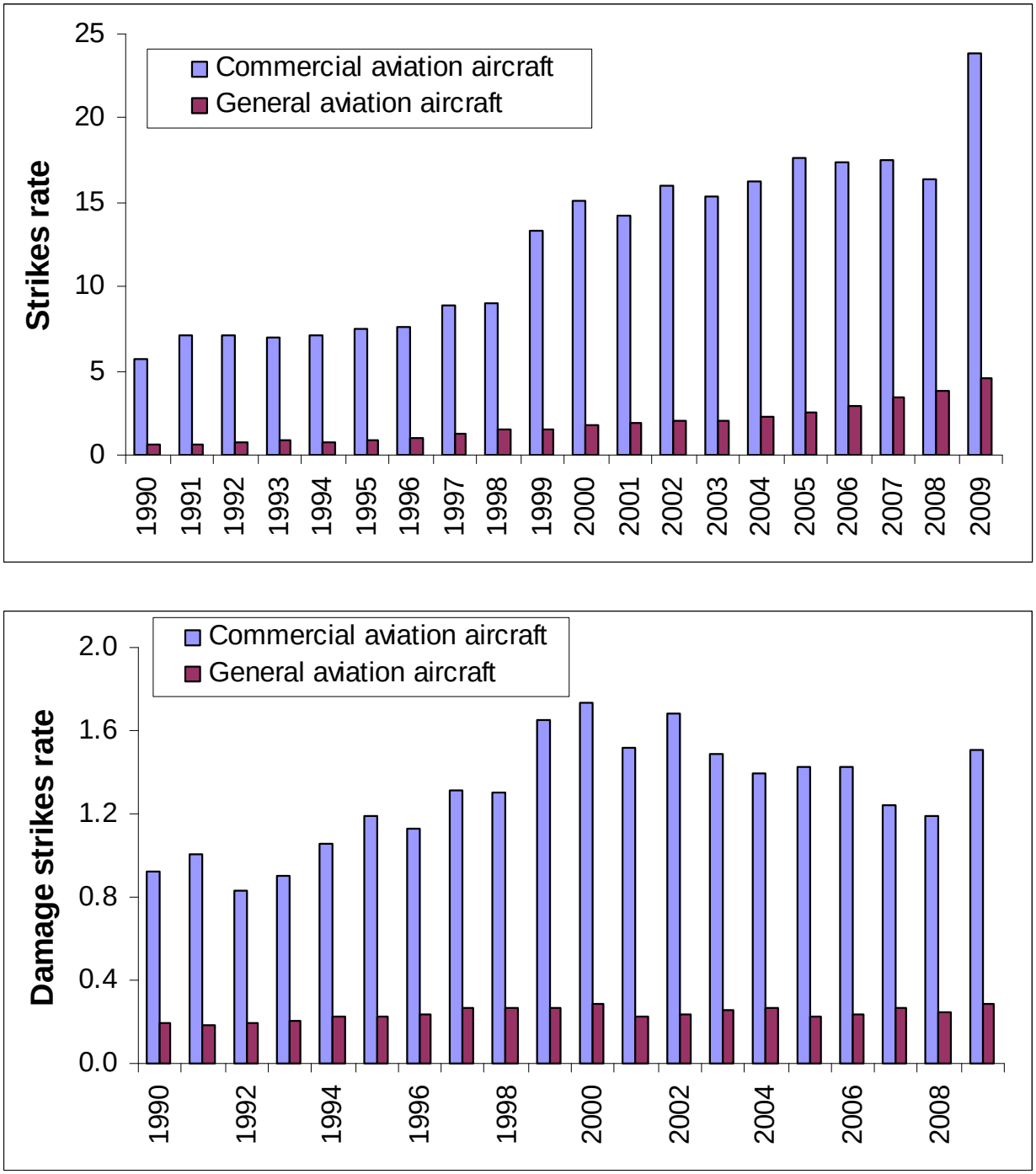


Figure 3. The strike rate (number of reported wildlife strikes per 100,000 aircraft movements, top graph) and damaging strike rate (number of reported damaging wildlife strikes per 100,000 aircraft movements, bottom graph) for commercial (air carrier, commuter, and air taxi service) and general aviation aircraft, USA, 1990–2009 (see Tables 2 and 3).

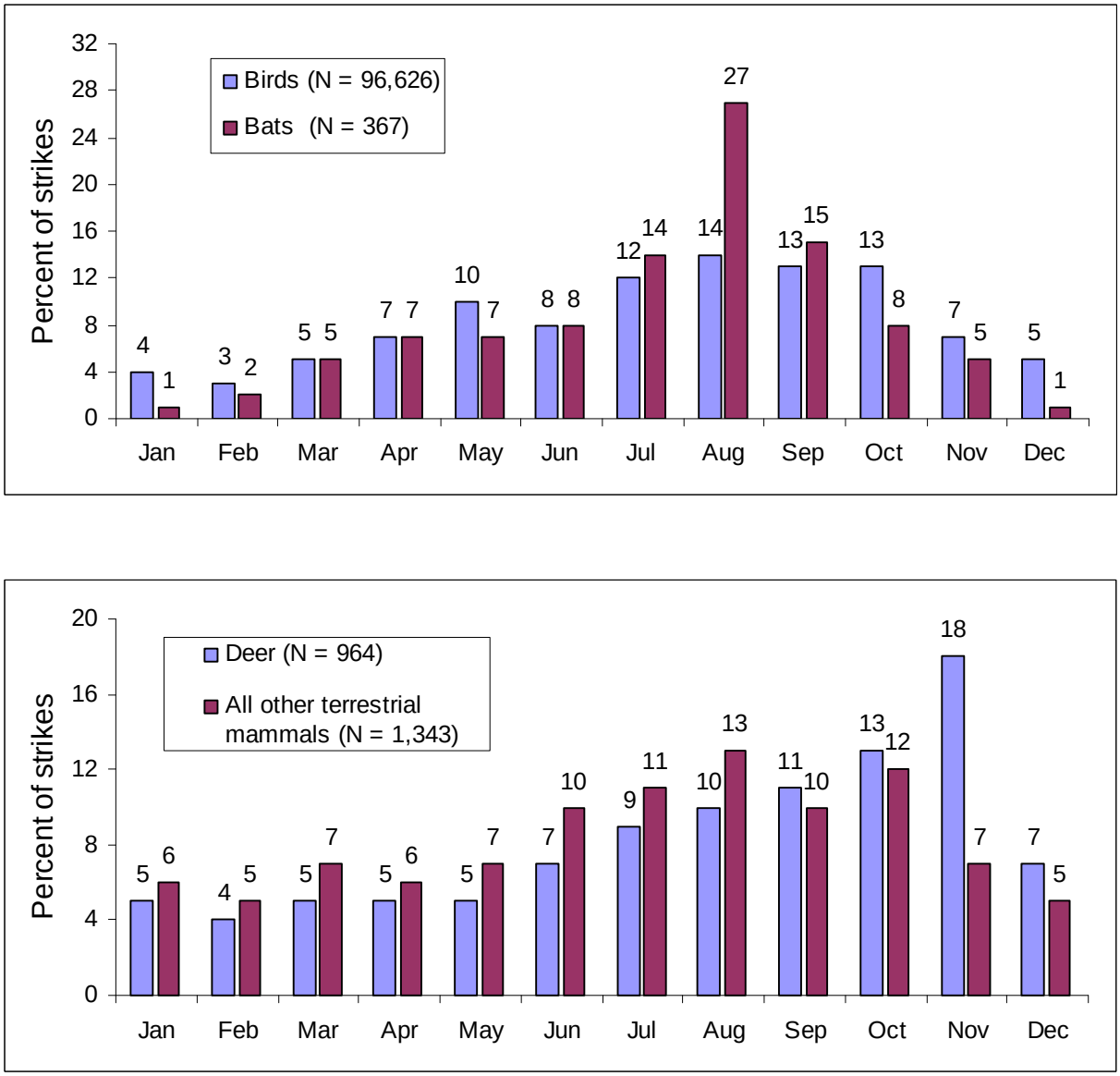
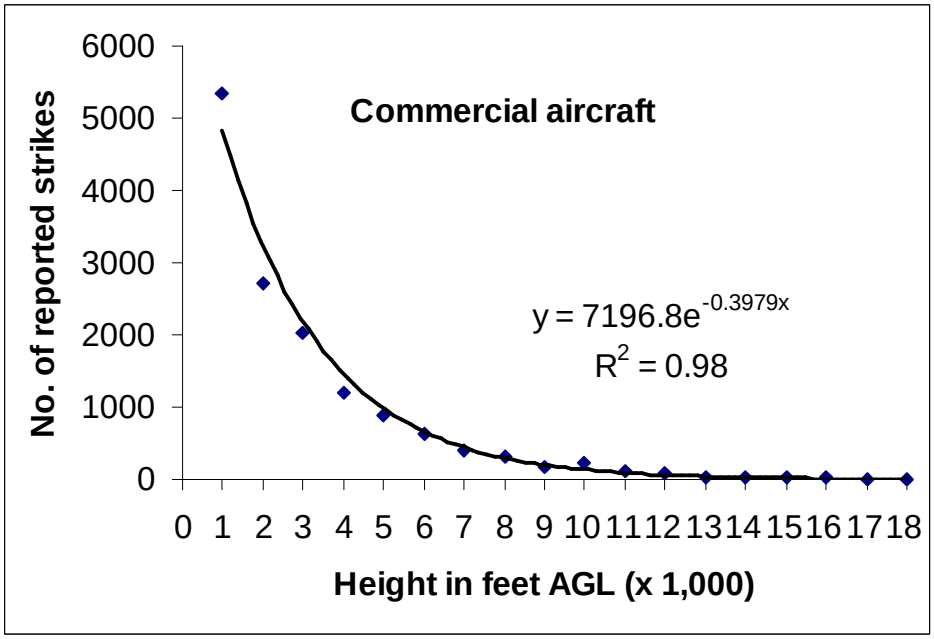


Figure 4. The percentage of reported bird and bat strikes (top graph) and deer and other terrestrial mammal strikes (bottom graph) with civil aircraft by month, USA, 1990–2009. In addition, 110 strikes with reptiles were reported, of which 58 percent occurred in May–July. Deer strikes comprised 879 white-tailed deer, 55 mule deer, and 30 deer not identified to species.



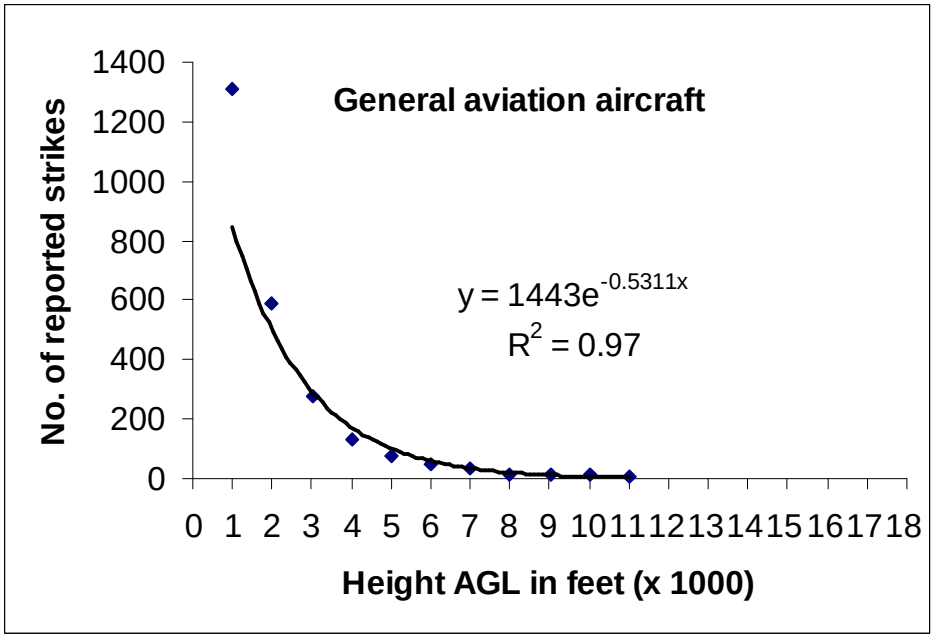


Figure 5. Number of reported bird strikes with commercial (top graph) and general aviation aircraft (bottom graph) in USA from 1990–2009 by eighteen 1,000-foot height intervals above ground level from 501–1,500 feet (interval 1) to 17,501–18,500 feet (interval 18). Above 500 feet, the number of reported strikes declined consistently by 33 percent and 41 percent for each 1,000 foot gain in height for commercial and general aviation aircraft, respectively. The negative exponential equations explained 97 to 98 percent of the variation in number of strikes by 1000-foot intervals from 500 to 18,500 feet. See Tables 10 and 11 for sample sizes.

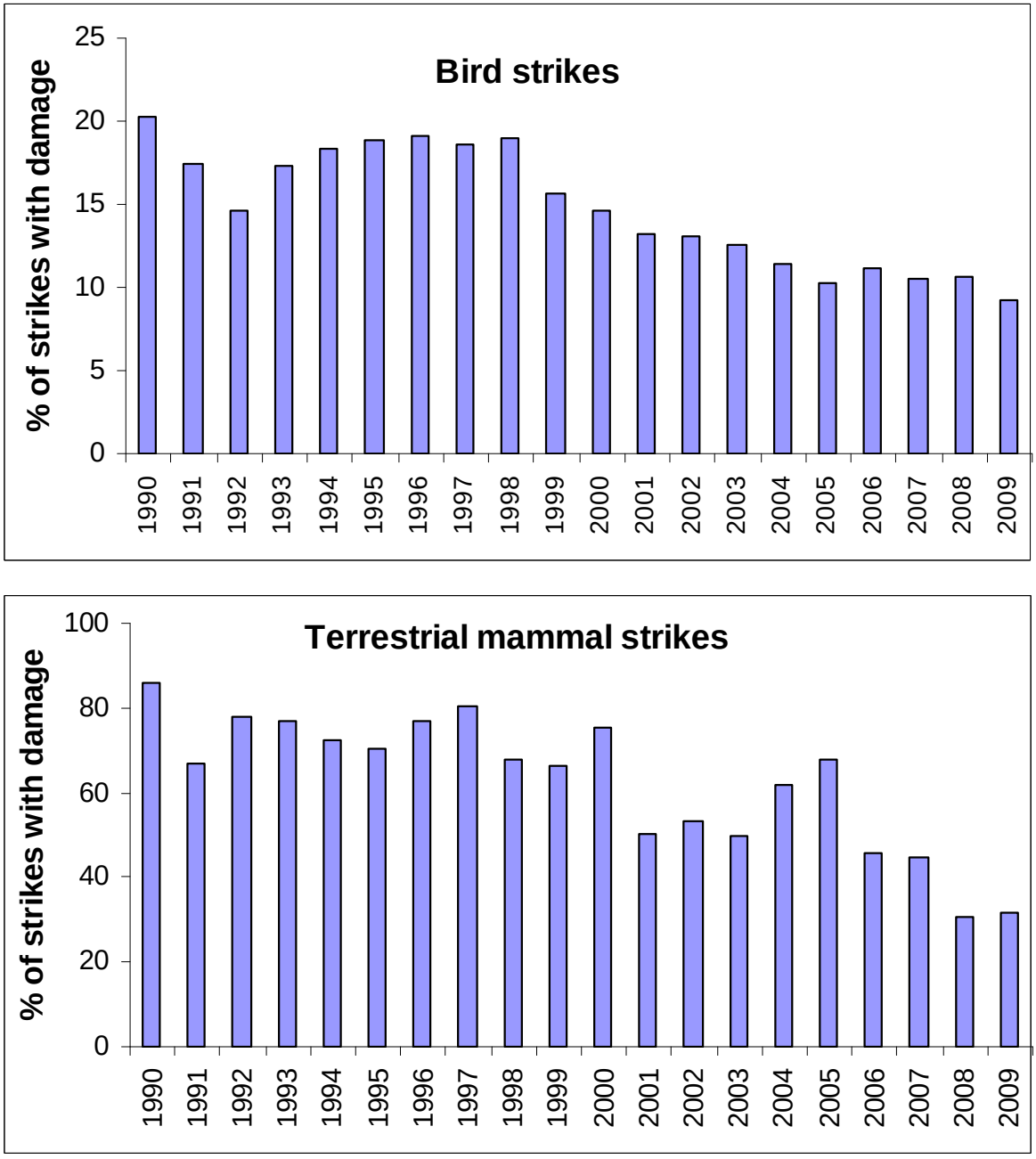


Figure 6. The percentage of reported bird strikes (top graph) and terrestrial mammal strikes (bottom graph) that indicated damage to the civil aircraft, USA, 1990–2009. See Tables 1 and 13 for sample sizes and classifications of damage.

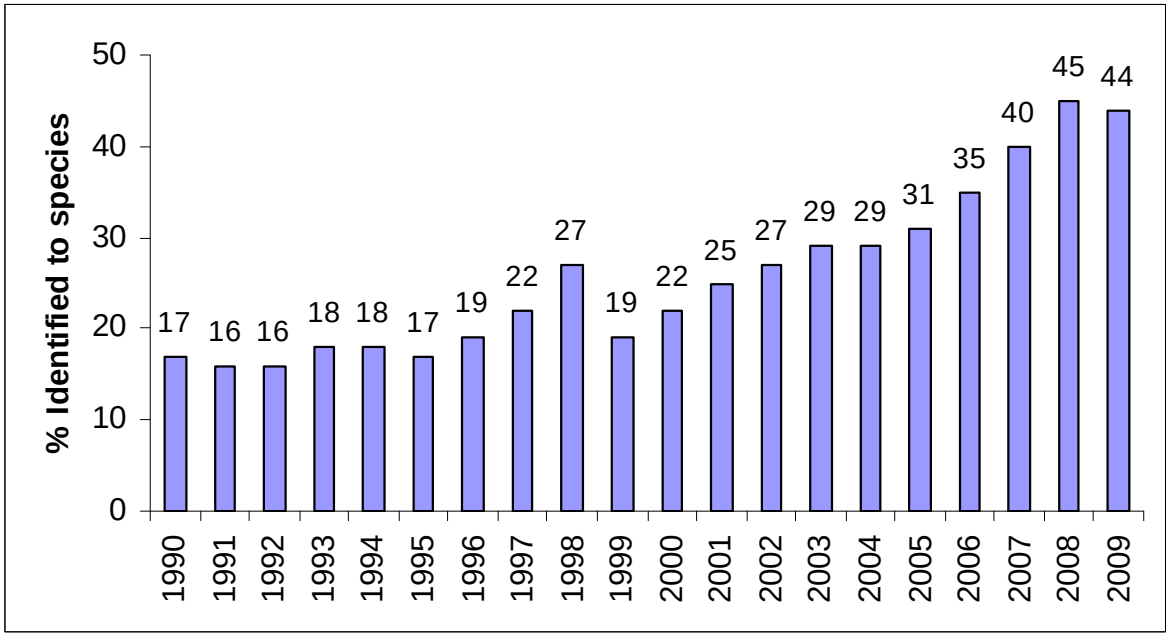


Figure 7. The percentage of reported bird strikes with civil aircraft in which the bird was identified to species, USA, 1990–2009. See Tables 1 and 15 for sample sizes.

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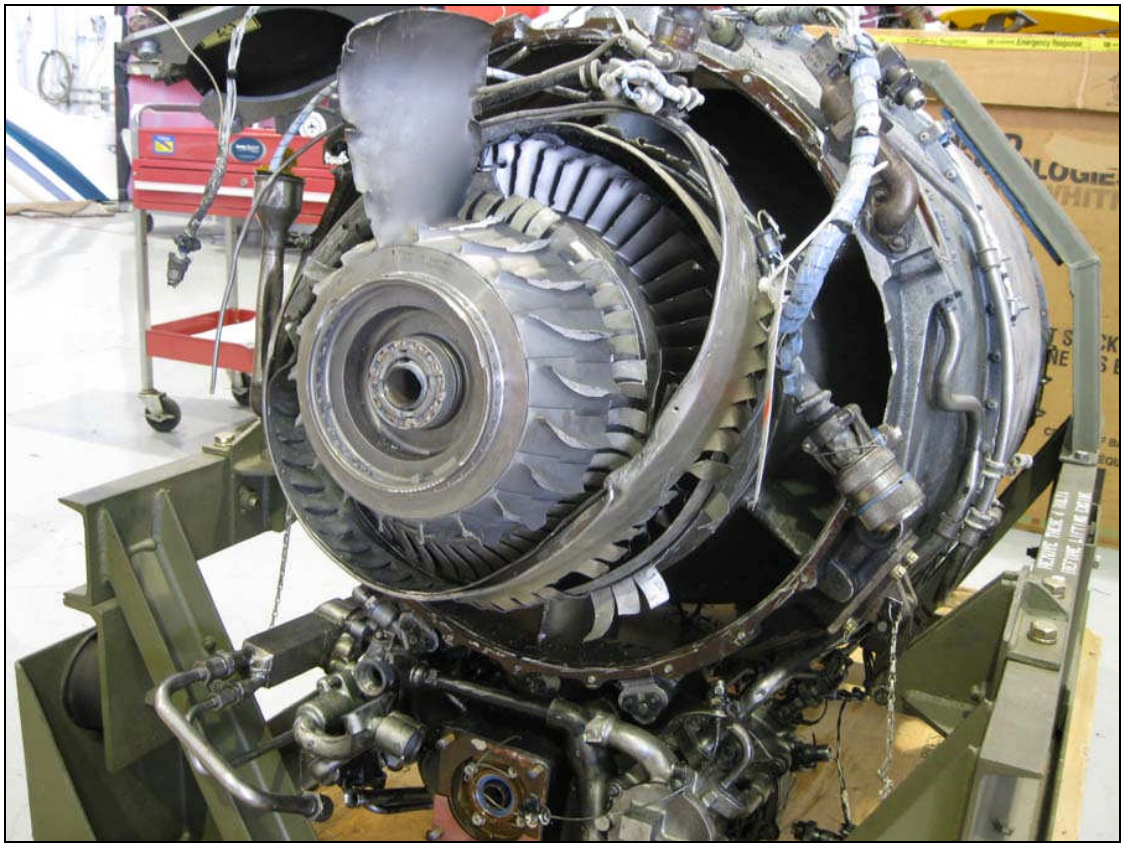
APPENDIX A.

SELECTED SIGNIFICANT WILDLIFE STRIKES TO U.S. CIVIL AIRCRAFT, 2009



A Beechcraft 400 departing a Texas airport on 31 July 2009 ingested a recently fledged yellow-crowned night heron into the #2 engine during the take-off run, causing an uncontained failure. The pilot aborted take-off. Photo courtesy USDA.

The U.S. Department of Agriculture, through an interagency agreement with the Federal Aviation Administration, compiles a database of all reported wildlife strikes to U.S. civil aircraft and to foreign carriers experiencing strikes in the USA. We compiled 99,411 strike reports from 1,585 USA airports and 237 foreign airports for 1990 through 2009 (9,474 strikes in 2009). The following 2009 examples from the database show the serious impact that strikes by birds or other wildlife can have on aircraft. These examples, from throughout the USA, demonstrate the widespread and diverse nature of the problem. The examples are not intended to highlight or criticize individual airports because strikes have occurred on almost every airport in the USA. Some of the strike examples reported here occurred off airport property during approach or departure. For more information on wildlife strikes or to report a strike, visit http://wildlife.faa.gov and www.birdstrike.org.

Date:	4 January 2009
Aircraft:	Sikorksy S-76C++
Airport:	Near Morgan City, LA
Phase of Flight:	En Route (700' AGL)
Effect on Flight:	Crashed in a marsh
Damage:	Aircraft destroyed
Wildlife Species:	Red-tailed hawk
Comments from Report: Helicopter crashed while en route to an offshore work site. Eight people were killed. One seriously injured. Initial analysis of the flight data recorder indicated that the helicopter was cruising at 138 knots when the cockpit voice recorder indicated a loud noise followed by a substantial increase in the background noise level that was recorded on both intercoms and area microphones. About one second after the loud noise, the torque of both engines dropped simultaneously to near zero. DNA and feather samples were taken from the windshield and right side engine inlet filter. Additional swabs were taken from various parts of the aircraft. NTSB investigated. ID by the Smithsonian, Division of Birds.	

Date:	5 January 2009
Aircraft:	B-747-400
Airport:	Chicago O'Hare Intl. (IL)
Phase of Flight:	Climb (<8,000 AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine #3
Wildlife Species:	Red-tailed hawk
Comments from Report: During climb, bird(s) was/were ingested in the #3 engine. Altitude of strike was not reported, but the aircraft turned back at around 8,000 feet AGL and dumped 30,000 kg of fuel. ID by the Smithsonian, Division of Birds. Aircraft out of service at least 3 days.	

Date:	15 January 2009
Aircraft:	A-320
Airport:	LaGuardia Intl. (NY)
Phase of Flight:	Climb (2,900' AGL)
Effect on Flight:	Engines shut down, landed in Hudson River
Damage:	Aircraft destroyed
Wildlife Species:	Canada goose
Comments from Report: During initial climb, aircraft had multiple birdstrikes and lost thrust in both engines. Pilot ditched in the Hudson River less than 6 minutes after take-off. Observers in offices along the river said the aircraft narrowly missed hitting buildings. Several boats were used to rescue the 150 passengers and 5 crew members as the aircraft sank. Everyone on board survived. Area hospitals treated several minor injuries and one serious injury. NTSB investigated. ID by the Smithsonian, Division of Birds. Geese were found to be migratory rather than resident. Cost of lost aircraft estimated at $36 million.	

Date:	17 January 2009
Aircraft:	Eurocopter AS 350
Airport:	Forrest City, AR
Phase of Flight:	En Route (1,200' AGL)
Effect on Flight:	Emergency landing
Damage:	Both windshields, chin bubble, engine nacelle, and nose
Wildlife Species:	Snow goose
Comments from Report: Helicopter hit a flock of birds around the Forrest City area and made an emergency landing. The a/c hit about 6 birds. Both windscreens were broken as well as the nose cone, engine nacelle, and pilot's chin bubble. The pilot suffered some minor injuries and everyone was shaken up. The crew members were not wearing helmets and were fortunate the pilot's vision remained intact to land the aircraft. Aircraft was trailered for repairs. Time out of service was 3 months and costs totaled $100,000.	

Date:	1 February 2009
Aircraft:	Schweizer G-164B
Airport:	Private airstrip near Ferriday, LA
Phase of Flight:	Approach (20' AGL)
Effect on Flight:	Impacted runway and flipped over
Damage:	Destroyed
Wildlife Species:	Double-crested cormorant and red-winged blackbirds
Comments from Report: While on short final, the bi-wing aircraft hit a flock of birds, which penetrated the windscreen and impacted pilot in the face, temporarily blinding him. Pilot attempted a go-around but aircraft impacted the runway, nosed over and came to rest inverted. Pilot reported a cormorant came through the windshield. Photo showed red-winged blackbirds on field. The fuselage sustained structural damage. NTSB investigated. Aircraft was destroyed.	

Date:	3 February 2009
Aircraft:	B-757-200
Airport:	Denver Intl. (CO)
Phase of Flight:	Climb (2,100’ AGL)
Effect on Flight:	Emergency landing
Damage:	Engine
Wildlife Species:	Bald eagle
Comments from Report: Amber alert precautionary landing. Pilot reported seeing and hitting a large bird during climb through 7,500 ft MSL. Bird hit right side of engine cowling making a large dent before entering the engine where it damaged all fan blades. Aircraft returned to Denver. ID by the Smithsonian, Division of Birds. Cost reported to be $14 - $20 million.	

Date:	16 February 2009
Aircraft:	B-757-200
Airport:	Mineta San Jose Intl. (CA)
Phase of Flight:	Take-off run
Effect on Flight:	Aborted take-off
Damage:	Engine
Wildlife Species:	California gull
Comments from Report: Saw gulls during taxi. During take-off run, captain saw birds on runway, they began flying, resulting in numerous strikes on fuselage and wings. Right engine began to vibrate significantly. Pilot aborted take-off, exited runway, and shut down the right engine. Passengers were bused to San Francisco, where they were booked on other flights. ID by the Smithsonian, Division of Birds.	

Date:	16 February 2009
Aircraft:	Cessna 402
Airport:	Fort Lauderdale Intl. (FL)
Phase of Flight:	Climb (600’ AGL)
Effect on Flight:	Precautionary landing
Damage:	Windshield
Wildlife Species:	Black vulture
Comments from Report: Pilot had just taken off when he saw a flock of vultures ahead. One smashed through the windshield, hitting the pilot in the face, causing injury. Blood splattered all over the cockpit. Firefighters were on hand for the landing. Pilots in the area have reported a growing vulture problem.	

Date:	5 March 2009
Aircraft:	Agusta 109E
Airport:	Shands Hospital (FL)
Phase of Flight:	Approach (700’ AGL)
Effect on Flight:	Emergency landing at base
Damage:	Windshield, switches, light
Wildlife Species:	Lesser scaup
Comments from Report: A duck shattered the windshield and entered the cockpit. The pilot received cuts and an eye injury. A trauma patient was on board as they approached the rooftop helipad at Shands Hospital. The bird broke switches and circuit breakers on the overhead instrument panel before landing on the foot of a crewmember. The aircraft landed at the ShandsCair helipad, rather than on the hospital roof. Patient was transported by ambulance. ID by the Smithsonian, Division of Birds, based on photo.	

Date:	16 March 2009
Aircraft:	B-757-200
Airport:	New Orleans Intl. (LA)
Phase of Flight:	Take-off run
Effect on Flight:	Precautionary landing
Damage:	Engine #2
Wildlife Species:	Herring gull
Comments from Report: Pilot reported seeing up to 10 gulls on the runway during rotation. Ingestion caused vibration in the #2 engine. An emergency was declared and aircraft returned to airport, landing safely. Smoke rings were seen coming from the engine during landing. Three blades were replaced along with a leaky hydraulic actuator. Passengers were booked on other flights. ID by Smithsonian, Division of Birds. Time out of service 24 hours.	

Date:	21 March 2009
Aircraft:	B-737-800
Airport:	Newark Liberty Intl. (NJ)
Phase of Flight:	Approach (1,200’ AGL)
Effect on Flight:	Engine shutdown
Damage:	Engine, wing, landing gear
Wildlife Species:	Canada goose
Comments from Report: On final approach, right engine ingested a Canada goose and flamed out repeatedly. Safe landing made. Emergency vehicles were dispatched. Damage to right engine and left leading edge of wing. Nose gear had bird lodged in it. ID by Smithsonian, Division of Birds.	

Date:	22 March 2009
Aircraft:	A-310
Airport:	Gerald R Ford Intl. (MI)
Phase of Flight:	Take-off run
Effect on Flight:	Aborted take-off
Damage:	Engine
Wildlife Species:	Snowy owl
Comments from Report: Five intake fan blades, 4 fan exit vane platforms, and acoustic liner sheet were damaged. ID by the Smithsonian, Division of Birds. Time out of service was 38 hours, cost reported as $303,500.	

Date:	3 May 2009
Aircraft:	C-414
Airport:	Cavern City Air Terminal (NM)
Phase of Flight:	Landing roll
Effect on Flight:	Lost brakes
Damage:	Engine, propeller, wing, landing gear
Wildlife Species:	Mule deer
Comments from Report: Three mule deer crossed the runway during landing. The right engine, right landing gear, and right flaps were damaged. The deer got caught in the landing gear. The right brakes were lost. Time out of service was 1 month.	

Date:	7 June 2009
Aircraft:	B-747-400
Airport:	Los Angeles Intl. (CA)
Phase of Flight:	Climb (150’ AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	Black-crowned night-heron
Comments from Report: At about ¼ mile off end of runway, a bird was ingested into the # 1 engine, which caused vibrations. Pilot entered a holding pattern to burn off fuel before returning to land. Seven fan blades were replaced. Time out of service was 33 hours. Cost of damage and other costs totaled $250,000. ID by Smithsonian, Division of Birds.	

Date:	26 June 2009
Aircraft:	Bell 407
Airport:	Odessa, DE
Phase of Flight:	En Route (700' AGL)
Effect on Flight:	Landed in a field
Damage:	Windshield, rotor, fuselage, tail, antenna, overhead switch panel
Wildlife Species:	Unknown (possibly vulture or eagle)
Comments from Report: Medic observer caught a brief glimpse of a large bird just prior to impact as it approached from the left side of the aircraft in the pilot's blind spot. Impact took place simultaneously with medic's warning. Both windshields were broken. Pilot sustained a small puncture to his left hand and minor lacerations and contusions to his neck, apparently from the Plexiglas windshield. Helmets were worn and visors were down. Remains were scattered throughout the cockpit. The pilot immediately landed in a field. Aircraft had to be trucked out for repairs. Time out of service was 16 days. Cost of repairs was $25,000.	

Date:	29 June 2009
Aircraft:	DC-9-31
Airport:	Gerald R. Ford Intl. (MI)
Phase of Flight:	Approach
Effect on Flight:	None
Damage:	Engine
Wildlife Species:	Mallard
Comments from Report: Remains found over large area covering 25' x 100' all left of runway centerline. Obvious ingestion. Largest piece less than 2.5" by 1". ATC had no reports of a birdstrike. Remains found at 1030. Operator found at 1320. Pilot unavailable. Engine had to be replaced. ID by Smithsonian, Division of Birds.	

Date:	30 June 2009
Aircraft:	B-737-800
Airport:	LaGuardia Intl. (NY)
Phase of Flight:	Approach (900' AGL)
Effect on Flight:	Aircraft was towed to gate
Damage:	Landing gear
Wildlife Species:	Great blue heron
Comments from Report: Aircraft hit a bird on approach. After landing, pilot noticed the nose gear's hydraulics were not working. A large bird was found in the landing gear. Aircraft had to be towed to the gate.	

Date:	4 July 2009
Aircraft:	Lancair LC-42
Airport:	Ocean City Municipal (NJ)
Phase of Flight:	Landing roll
Effect on Flight:	Ran off runway
Damage:	Propeller, landing gear, engine cowling and airframe
Wildlife Species:	Canada goose
Comments from Report: During landing roll, aircraft hit two Canada geese. The plane veered off the right side of the runway and hit a concrete runway light-mounting pad. The nose landing gear collapsed and the nose wheel assembly separated from the landing gear. The right main landing gear and its wheel assembly were damaged, and the brake wheel backer plate was jammed against its wheel assembly preventing rotation. The engine was rebuilt.	

Date:	7 July 2009
Aircraft:	B-737-300
Airport:	Baltimore Washington Intl. (MD)
Phase of Flight:	Climb (25’ AGL)
Effect on Flight:	Precautionary landing
Damage:	Engines #1 and #2, tail
Wildlife Species:	European starling
Comments from Report: Birds were ingested in both engines. The number 2 first stage fan sustained many bent blades and the #1 engine had 1 blade damaged. The right horizontal stabilizer was dented, and the leading edge was replaced. No internal engine damage found during borescope inspection. The landing gear, wing, and radome were hit numerous times but sustained no damage. Approximately 67 starlings were removed from the runway. Aircraft was out of service 4.5 hours.	

Date:	31 July 2009
Aircraft:	Embraer 120
Airport:	Salt Lake City Intl. (UT)
Phase of Flight:	Climb (2,600’ AGL)
Effect on Flight:	Precautionary landing
Damage:	Radome
Wildlife Species:	White pelican
Comments from Report: A pelican hit the aircraft as it climbed to about 2,600’ AGL. Aircraft returned to the airport with the bird lodged in the radome. Time out of service was 48 hours. Cost of repairs was $150,000.	

Date:	31 July 2009
Aircraft:	BE-400
Airport:	Sugar Land Regional (TX)
Phase of Flight:	Take-off run
Effect on Flight:	Aborted take-off, uncontained engine failure
Damage:	Engine
Wildlife Species:	Yellow-crowned night-heron
Comments from Report: During take-off run, approaching 95 knots, the pilots saw 1 large and 2 smaller birds. The larger bird was ingested into the #2 engine, which immediately rolled back. Take-off was aborted. The engine cowling and multiple turbine blades had separated from the aircraft. It is believed that the bird hit the spinner, which fell into the fan. One wing and material from inside the engine were sent to the Smithsonian. NTSB investigated. ID by Smithsonian, Division of Birds.	

Date:	15 August 2009
Aircraft:	MD-11
Airport:	Los Angeles Intl. (CA)
Phase of Flight:	Climb (100’ AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	Western gull
Comments from Report: Pilot reported a bird strike upon rotation. The aircraft returned with a bird ingestion in the #1 engine. Emergency was declared with a heavy landing. Six turbine blades were replaced. ID by Smithsonian, Division of Birds. Cost estimated at $135,000, and time out of service was 30 hours.	

Date:	17 August 2009
Aircraft:	Embraer 175
Airport:	Charlotte/Douglas Intl. (NC)
Phase of Flight:	Take-off run
Effect on Flight:	Aborted take-off
Damage:	Engine, landing gear
Wildlife Species:	Canada goose
Comments from Report: During take-off run, encountered a large flock of geese. One bird was ingested in the #2 engine, one hit the nose landing gear, and another hit the right landing gear. The pilot made a high-speed aborted take-off, stopping safely, and taxied to the apron. The flight was delayed for 2.5 hrs while a replacement aircraft was brought in. ID by Smithsonian, Division of Birds.	

Date:	29 September 2009
Aircraft:	B-727-200
Airport:	Memphis Intl. (TN)
Phase of Flight:	Approach (3,700' AGL)
Effect on Flight:	None
Damage:	Windshield
Wildlife Species:	Great egret
Comments from Report: The captain's front window was struck, and the inner window panel shattered. Two engines ingested birds but sustained no damage. Time out of service was 37 hours. Cost estimated at $10,820. ID by Smithsonian, Division of Birds.	

Date:	11 October 2009
Aircraft:	MD-88
Airport:	Greater Rochester Intl. (NY)
Phase of Flight:	Climb (200' AGL)
Effect on Flight:	Engine shut down and precautionary landing
Damage:	Engine
Wildlife Species:	Unknown
Comments from Report: Aircraft hit a flock of birds during climb from ROC. Left engine stalled, and there was an in-flight shutdown. Unknown if pilot commanded the shutdown. Returned to land. The left engine had multiple fan blades with major damage.	

Date:	18 October 2009
Aircraft:	Piaggio P 180
Airport:	Monmouth Executive Airport (NJ)
Phase of Flight:	Take-off run
Effect on Flight:	Aborted take-off
Damage:	Nose, propeller, wing, fuselage
Wildlife Species:	Canada goose
Comments from Report: Bird struck the nose cone, which damaged the radar and avionics bay. Both propellers were damaged. Engine nacelles needed to be repaired. Minor damage to left wing. Time out of service was 8 days. Cost totaled $105,000.	

Date:	2 November 2009
Aircraft:	MD-90
Airport:	Phoenix Sky Harbor Intl. (AZ)
Phase of Flight:	Climb (9,300' AGL)
Effect on Flight:	Precautionary landing
Damage:	Fuselage
Wildlife Species:	Western grebe
Comments from Report: Bird hit top of aircraft and tore back 18 inches of the fuselage just above the right flight deck eyebrow window. A second strike tore a large hole just below the co-pilot's wing in front of the landing gear. These strikes activated the depressurization alarm. Aircraft returned to land. NTSB investigated. ID by Smithsonian, Division of Birds	

Date:	4 November 2009
Aircraft:	BE-99
Airport:	Show Low Regional (AZ)
Phase of Flight:	Approach (~6800' AGL)
Effect on Flight:	Emergency landing
Damage:	Windshield
Wildlife Species:	Western grebe
Comments from Report: Bird shattered the windshield, injuring the pilot. NTSB investigated. ID by Smithsonian, Division of Birds.	

Date:	14 November 2009
Aircraft:	A 319
Airport:	Kansas City Intl. (MO)
Phase of Flight:	Climb (4,000' AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine
Wildlife Species:	Snow goose
Comments from Report: Flight had just departed when pilot reported multiple bird strikes about 4 miles north of the airport. First report was loss of #2 engine. When the crew attempted to advance the throttle, there was a series of severe compressor stalls. Passengers described it as fireballs being ejected from the engine. The crew declared an emergency and returned to MCI. Upon landing, pilot reported both engines had stalled. Damage to #2 engine consisted of a dent in the lower lip and a hole in the underside of the cowling. The # 2 engine had internal damage. NTSB investigated. ID by Smithsonian, Division of Birds.	

Date:	6 December 2009
Aircraft:	Embraer 145
Airport:	Philadelphia Intl. (PA)
Phase of Flight:	Approach (2,000' AGL)
Effect on Flight:	Engine shut down
Damage:	Engine
Wildlife Species:	Snow goose
Comments from Report: Pilot declared an emergency due to a bird strike and engine shutdown while on approach. A huge bang shook the aircraft, and then the engine went out. Time out of service was 48 hours, and costs were $306,000. ID by Smithsonian, Division of Birds.	

Date:	22 December 2009
Aircraft:	B-717-200
Airport:	Baltimore Washington Intl. (MD)
Phase of Flight:	Climb (3,500' AGL)
Effect on Flight:	Precautionary landing
Damage:	Nose, wing, fuselage, engine cowling and engine
Wildlife Species:	Snow goose
Comments from Report: Multiple strikes with bird debris on wings and nose. The pilots reported that they hit 6 or 7 geese 4 miles west after departure. Pilots reported flight control problems, abnormal vibrations in both engines and upon landing, the #1 engine was smoking. ID by Smithsonian, Division of Birds.	

Date:	22 December 2009
Aircraft:	B-727-200
Airport:	Edmonton Intl. (Alberta, Canada)
Phase of Flight:	Climb (100' AGL)
Effect on Flight:	Precautionary landing
Damage:	Engine #3
Wildlife Species:	Short-eared owl
Comments from Report: Aircraft maintenance performed a bird strike inspection on the #2 engine after it was removed from the aircraft for ice FOD. Evidence of strike was found. Time out of service was 41 hours. Costs totaled $1.3 million. ID by Smithsonian, Division of Birds. (USA carrier)	